SIEMENS

SIMATIC

SIMATIC NET
Twisted-Pair and Fiber-Optic Networks

Manual

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Subject to technical change.

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Twisted-pair cable

Duplex fiber-optic cable

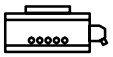
Industrial Ethernet triaxial cable

Terminating resistor for triaxial cable

727-1 drop cable

MINI OTDE optical transceiver (BFOC)

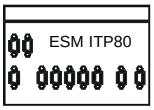
Mini UTDE electrical transceiver (RJ-45)


Transceiver

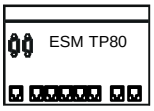
Industrial Ethernet ELM (Electrical Link Module)

Industrial Ethernet OLM (Optical Link Module)

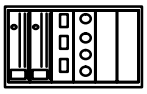
Industrial Ethernet OSM (Optical Switch Module)

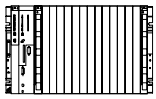


Industrial Ethernet ESM (Electrical Switch Module)

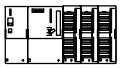


Industrial Ethernet ESM (Electrical Switch Module)


Active star coupler (ASGE) with ECTP3 and ECFL2



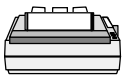
SIMATIC S7-400



SIMATIC S7-300

Operator panel (OP)

Programming device (PG)



Printer

Personal Computer (PC)

1.2 Local Area Networks in Manufacturing and Process Automation

General

The performance of control systems is no longer simply determined by the programmable logic controllers, but also to a great extent by the environment in which they are located. Apart from operator control and monitoring, this also means a high-performance communication system.

Distribution in Manufacturing and Process Automation

Distributed automation systems are being used increasingly in manufacturing and process automation. This means that a complex control task is divided into smaller, clearly delineated subtasks with distributed control systems. As a result, efficient communication between the distributed systems is an absolute necessity. Such distributed structures have, for example, the following advantages:

- Independent and simultaneous startup of individual sections of a plant or process
- Smaller, clearer programs
- Parallel processing by distributed automation systems (programmable controllers)
  This results in the following:
  - Shorter reaction times
  - Reduced load on the individual processing units
- Increased plant or process availability

A comprehensive, high-performance communication system is a must for a distributed system structure. The basis of such communication systems are Local Area Networks (LANs) that can be implemented in one of the following ways:

- Electrically
- Optically
- As an electrical/optical combination

What Does SIMATIC NET Stand For?

With SIMATIC NET, SIEMENS provides open, heterogeneous communication systems for the various levels of process automation in an industrial environment.

The communication systems are based on national and international standards according to the ISO/OSI reference model.

SIMATIC NET includes the following:

- The communication network consisting of the transmission media, medium attachment and transmission components, and the appropriate transmission techniques
- Protocols and services for data transmission between the devices mentioned above
- The modules of the programmable logic controller or computer that establish a connection to the communication network (communications processors “CPs”)

1.2.1 The SIMATIC NET Communication Systems

To handle the wide variety of tasks in automation engineering, SIMATIC NET provides different communication networks to suit the particular situation.

The topology of rooms, buildings, factories, and complete company complexes and the prevalent environmental conditions mean different requirements.

The networked automation components also make different demands on the communication system. To meet these various requirements, SIMATIC NET provides the following communication networks complying with national and international standards:

- AS-interface
  The Actuator-Sensor interface (AS-i) for automation at the lowest automation level for connecting binary actuators and sensors to programmable controllers via the AS-i bus cable.
- PROFIBUS
  A communication network for the cell and field area complying with the PROFIBUS standard EN 50170-1-2 or IEC 61158-2 with the hybrid medium access technique token bus and master-slave. This network is operated on a twisted-pair or fiber-optic cable.
- Industrial Ethernet
  A communication network for the cell area using baseband technology complying with IEEE 802.3 and using the CSMA/CD medium access method. The network is operated at a transmission rate of 10 Mbps on triaxial cable, glass fiber-optic cable, or shielded twisted pair cable.
- Fast Industrial Ethernet
  A communication network with a transmission rate of 100 Mbps.
  This network is implemented using glass fiber-optic cable or shielded twisted pair cable.

The various SIMATIC NET communication systems can be used alone or combined with the other systems.

Industrial Ethernet Networks 2

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Communication in an Industrial Environment

The requirements of communication in an industrial environment differ significantly from those of conventional office communication. This affects practically all aspects of communication, such as active and passive network components, attached DTEs, network concepts/topologies, availability, data traffic, and environmental conditions, to name but a few.

There are also network protocols optimized specifically for industrial communication, although recently TCP/IP, a classic protocol from office communication has started to gain ground in manufacturing and process control.

Industrial Ethernet - Designed for Industry

The basic idea behind Industrial Ethernet is to use existing standards (Ethernet network standards IEEE 802.3) and to add necessary and useful details specifically for industrial communication.

This results in products with properties adapted to the requirements of a manufacturing and process environment: Industrial Ethernet - Designed for Industry.

2.1 Ethernet Standard IEEE 802.3

IEEE Standard 802.3

The international “Institute of Electrical and Electronic Engineers (IEEE)” specified the first Ethernet standard 10BASE5 /1/ in 1985. This standard based on coaxial cable as the transmission medium was the basis for the first Industrial Ethernet. Under the name SINEC H1, this network, enhanced by the introduction of a triaxial cable, has proved itself for many years in process and manufacturing automation /6/.

From the very beginning, both the IEEE standard and the SIMATIC NET range of products have constantly been improved and expanded, further increasing the flexibility and performance of Ethernet networks. These expansions and improvements include, for example, the introduction of transmission on fiber-optic cables and twisted-pair cables and the introduction of Fast Ethernet increasing the transmission rate by a factor of 10.

The common basis of all these Ethernet versions is baseband signaling and the CSMA/CD medium access protocol.

Baseband Signaling

According to IEEE 802.3, Ethernet uses the baseband signaling technique. This means that data is transmitted unmodulated in pulse form on the transmission medium (for example bus cable). The transmission medium forms a single transmission channel whose capacity must be shared by the attached DTEs. All attached DTEs receive the data transmitted on the medium at the same time. At any one time, only one single DTE is permitted to send data. If more than one DTE sends data at the same time, a collision occurs on the transmission medium. The data signals of the DTEs attempting to transmit destroy each other.

Coordinated access to the common transmission medium is obviously necessary. The IEEE 802.3 standard solves this problem using the CSMA/CD protocol.

Network Access Using the CSMA/CD Protocol

CSMA/CD (Carrier Sense Multiple Access with Collision Detect) is also known as Listen While Talk (LWT).

This is a distributed access technique; in other words, each DTE connected to the network has the same access rights.

If a DTE wants to send data, it first “listens” to the medium to find out whether another DTE is already transmitting. If no other DTE is transmitting, it can start its transmission. If the DTE detects that the transmission medium is being used by a different DTE, it must wait until the medium is free again.

All DTEs listen to the data transmitted. Based on the destination address information in the data, a DTE recognizes whether or not it should receive the data.

If more than one DTE wants to send at the same time and they all detect that the medium is free, they start to transmit. After a brief time, the transmitted data will collide.

The DTEs have a mechanism that allows them to detect such collisions. All the DTEs involved in the collision then stop transmitting, wait for a random time calculated differently for each individual DTE, and then attempt to send the data again. This is repeated until one DTE succeeds in transmitting without a collision. The others then wait until the transmission medium is free again.

Collision Domain

To make sure that the CSMA/CD access technique functions correctly, the span of an Ethernet network is limited by the maximum permitted propagation time of a data packet. The distance within which the CSMA/CD protocol functions perfectly is known as the collision domain. In the classic 10 Mbps Ethernet, the collision domain is a span of 4520 m. The configuration rules resulting from these restrictions can be found in the section “Network Configuration”.

2.2 Industrial Ethernet

Industrial Twisted Pair (10BASE-T)

Industrial Twisted Pair is based on the Twisted-Pair standard IEEE 802.3i (10BASE-T) /3/ and operates at a transmission rate of 10 Mbps.

The transmission medium is a shielded cable with two twisted pairs with a characteristic impedance of 100 ohms. It is terminated according to the 10BASE-T standard with RJ-45 connectors. As an alternative, sub-D connectors are also available in the SIMATIC NET product range.

Twisted pair connections are always end-to-end connections between two electrically active components. This means that there is always a direct link from one DTE to a port of a network component. The network component is responsible for regenerating received signals and distributing them by outputting the data again to all output ports. In the SIMATIC NET Industrial Ethernet network, these tasks are handled by the OLM, ELM, OSM, and ESM network components. The maximum length of the link between a DTE and network component (known as the link segment) must not exceed 100 m.

Fiber Optic (10BASE-FL)

The fiber-optic variant for the 10 Mbps transmission rate in Industrial Ethernet is based on the IEEE 802.3i standard (10BASE-FL) /4/.
The transmission medium is a multimode fiber-optic cable with glass fibers of the type 62.5/125 µm or 50/125 µm.
Fiber-optic links are always end-to-end links between two active components. This means that there is always a direct link between a network component and a port of another network component. One network component is responsible for regenerating received signals and distributing them by outputting the data again to output ports. In SIMATIC NET Industrial Ethernet networks, this task is handled by the OLM network component.

2.3 Fast Ethernet

Fast Ethernet /5/ has the essential features of the classic Ethernet standard with a data rate increased by a factor of 10 to 100 Mbps. The data format, the CSMA/CD protocol and the glass fiber-optic cables and category 5 twisted-pair cables are identical in both systems.

SIMATIC NET products support the following Fast Ethernet specifications:

- 100BASE-TX over category 5 twisted-pair cable (two pairs)
- 100BASE-FX over fiber-optic cable (2 fibers)

Table 2-1 Ethernet/Fast Ethernet Compared

	Ethernet	**Fast Ethernet**
IEEE standard	802.3	802.3u
Data rate	10 Mbps	100 Mbps
Duration of a bit	100 ns	10 ns
Access technique	CSMA/CD	
Longest packet	1518 bytes	
Shortest packet	64 bytes	
Address field length	48 bits	
Topology	star, tree, bus	

Table 2-1 Ethernet/ Fast Ethernet in SIMATIC NET

	Ethernet	**Fast Ethernet**
Supported media	Coax: 10BASE5 Twisted pair: 10BASE-T FO: 10BASE-FL	Twisted pair: 100BASE-TX FO: 100BASE-FL
Network components	Transceivers OLM ELM ASGE Mini UYDE Mini OTDE	OSM ESM
Max. length of a TP trunk segment	100 m	100 m
Max. length of an FO trunk segment	Multimode: 3000 m	Multimode: 3000 m Single mode: 26 km

Industrial Twisted Pair (100BASE-TX)

Fast Ethernet over twisted pair is based on the standard IEEE 802.3u (100BASE-TX) /5/ and operates at a transmission rate of 100 Mbps. The transmission medium is a shielded cable with two twisted pairs with a characteristic impedance of 100 ohms. The transmission properties of this cable must meet the requirements of category 5 cabling (see Glossary). The maximum length of the link between a DTE and network component (known as the link segment) must not exceed 100 m. Termination is according to the 100BASE-TX standard with RJ-45 connectors, as an alternative, sub-D connectors are available in the SIMATIC NET product range.

Twisted pair connections are always end-to-end connections between two electrically active components. This means that there is always a direct link from one DTE to a port of a network component. The network component is responsible for regenerating received signals and distributing them by outputting the data again to output ports. In SIMATIC NET Industrial Ethernet networks, this task is handled by the OSM and ESM network components.

Fiber Optic (100BASE-FX)

The fiber-optic variant for 100 Mbps transmission rate in Industrial Ethernet is based on the IEEE 802.3u standard (100BASE-FX) /5/. The transmission medium is a multimode fiber-optic cable with glass fibers of the type 62.5/125 µm or 50/125 µm or a single mode fiber-optic cable with glass fibers of the type 10/125 µm.

Fiber-optic links are always end-to-end links between two active components. This means that there is always a direct link between a network component and a port of another network component. One network component is responsible for regenerating received signals and distributing them by outputting the data again to output ports. In the optical SIMATIC NET Industrial Ethernet network, these tasks are handled by the Optical Switch Module (OSM) network component.

2.4 Switching

Basic Principles of Switching

Switches forward data packets directly from the input port to the output port based on the address information in the data packet. Switches allow, as it were, a direct interconnection.

A switch has essentially the following functions:

- Connecting Collision Domains / Subnets

  Since repeaters and hubs (star couplers) function at the physical layer, their use is restricted to the span of a collision domain.

  Switches interconnect collision domains. Their use therefore is not restricted to the maximum span of a repeater network. Switches actually permit very large networks to be implemented with spans of up to 150 km.

- Load Containment

  By filtering the data traffic based on the Ethernet (MAC) addresses, local data traffic remains local. In contrast to repeaters or hubs, which distribute data unfiltered to all ports / network nodes, switches operate selectively. Only data intended for nodes in other subnets is switched from the input port to the appropriate output port of the switch.

  To make this possible, a table assigning Ethernet (MAC) addresses to output ports is created by the switch in a “teach-in” mode.

- Limitation of Errors to the Network Segment Affected

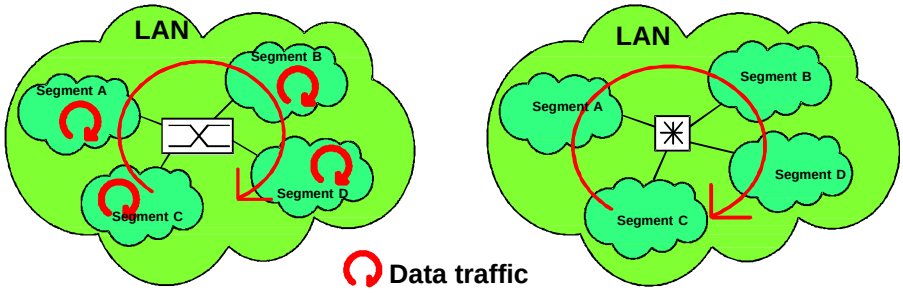
  By checking the validity of a data packet on the basis of the checksum which each data packet contains, the switch ensures that bad data packets are not transported further. Collisions in one network segment are not passed on to other segments.

- Parallel Communication

  Switches have the capability of handling multiple data packets between different network segments or nodes simultaneously.

  Depending on the number of ports the switch has, it establishes several temporary and dynamic links between different pairs of network segments/terminals.

  The result is an enormous increase in the network's data throughput, and a considerable increase in network efficiency.



Switched LAN

- Each individual segment has the full range of performance / data rate
- Simultaneous data traffic in several segments; several frames
- Filtering:
  Local data remains local; only selected packets go beyond segment limits

Shared LAN

- All nodes on the network share the network performance / data rate
- All data packets pass through all segments
- At any one time, only one frame on the network
- Collisions reduce the efficiency of the network to approx. 40%

Figure 2-1 Switched LAN / Shared LAN Compared

2.5 Example of an Industrial Ethernet Network

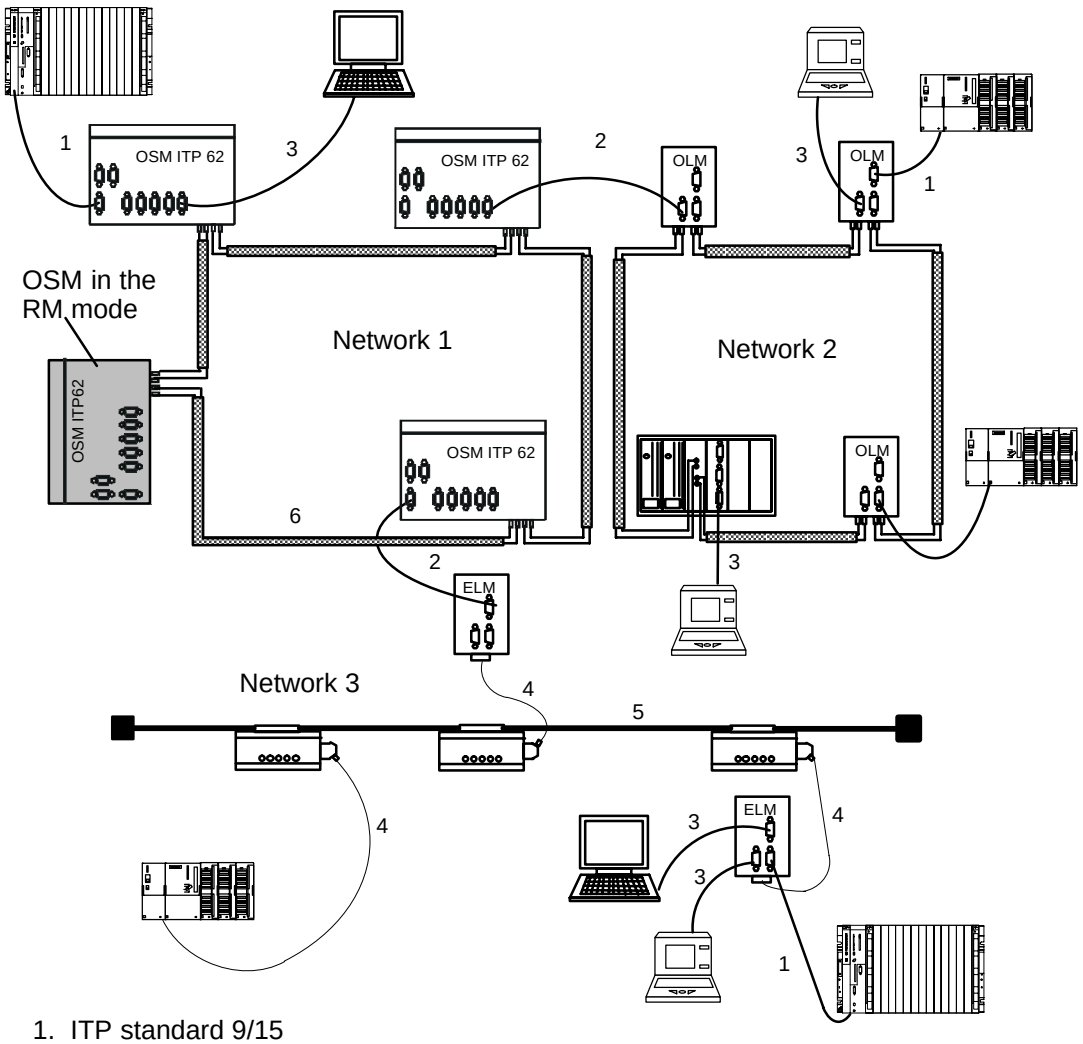
Figure 2-2 shows an example of the combination of different technologies and generations of Industrial Ethernet products in one network.

Network 1
In the high-speed network 1, four OSMs form a redundant ring with 100 Mbps transmission capacity. If the connected DTEs or network components are suitably designed, the twisted-pair ports of the OSMs can also be operated at 100 Mbps. Since OSMs operate as switches, only the maximum lengths of the individual port connections need to be taken into account during configuration (100 m twisted pair, 3000 m fiber optic).

Network 2
Network 2 also forms a redundant ring. The OLM and star coupler ASGE network components operate at 10 Mbps using the CSMA/CD medium access method. The maximum lengths of the individual port connections are limited to 100 m for twisted pair and 3100 m for fiber-optic between two OLMs. The limits of the collision domains (max. possible signal propagation time between two nodes) must also be kept to.

Network 3
Network 3 represents a small system that has existed for years and that is based on triaxial cable. A SIMATIC NET ELM allows the system to be connected to a modern large network with switching technology.

Example of an Industrial Ethernet Network



1. ITP standard 9/15
2. TP XP Cord
3. TP Cord 9/RJ-45
4. 727-1 drop cable
5. Triaxial cable
6. Fiber-optic cable (FO)

Figure 2-2 Network Structure with Industrial Ethernet Network Components

Configuring Networks

3

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3.1 Shared LANs (CSMA/CD Networks)

Shared LAN

The main feature of shared LANs is that all attached components share the bandwidth of the transmission medium. At any one time, there can only be one data packet in transit through the network. All data packets pass through all segments. One station sends while all others receive. The station obtains the right to send according to the CSMA/CD medium access method. The products that operate according to the CSMA/CD medium access method and therefore form shared LANs include the OLM/ELM, Mini UTDE, Mini OTDE, ASGE star coupler.

Using these components, it is possible to create bus, star and ring structures. The rules for the network configuration are explained in this chapter. In this respect, it is advisable to make a distinction between the length restrictions of individual fiber-optic, twisted pair or AUI links dictated by attenuation characteristics and the limits of the entire network span (collision domain) as dictated by the Ethernet principle.

Note

For detailed information about configuring, installing, and operating components of the SIMATIC NET triaxial network, refer to the manual for triaxial networks (German/English, order number 6GK1 970-1AA20-0AA0)

3.1.1 Fiber-Optic Links

The optical ports of the OLM, Mini OTDE, ECFL2, and ECFL4 (interface cards for the ASGE) comply with the IEEE 802.3j: 10BASE-FL standard. This means that these ports can be linked in any combination.

The ideal media for these links are multimode glass fibers of the type 50/125 µm or 62.5/125 µm.

The length of the FO link that can be inserted depends on the optical power budget available and the optical power loss at a wavelength of 850 nm.

FO Link Power Budget

A fiber-optic link power budget is available between the transmitter and receiver on a fiber-optic link.

This represents the difference between the optical power coupled into a particular fiber by an optical transmitter and the input power required by an optical receiver for problem-free signal recognition.

Optical Budget in SIMATIC NET Industrial Ethernet (10BASE-FL)

The 10BASE-FL optical ports operate at a wavelength of 850 nm. In Industrial Ethernet, the following optical budget is available:

- 50/125 µm fiber: 8 dBm
- 62.5/125 µm fiber: 11 dBm

This power budget can be “used up” as power loss through the fiber-optic transmission path.

Optical Power Loss

The optical power loss is the cumulative value of all the losses occurring in the fiber-optic transmission path. These losses can be attributed mainly to the following causes:

- Power loss within the fiber itself at a wavelength of 850 nm (refer to the technical specifications of the particular fiber)
- Power loss caused by splices (approximately 0.2 dB per splice)
- Power loss caused by connectors (approximately 0.4 dB per connector)

The values in brackets are approximate values that can be used as a guideline when configuring a network. The actual link loss should always be checked after the link has been installed using a power loss measuring device.

If the power loss is equal to or lower than the power budget, the planned fiber-optic link can be implemented.

The optical power is generally specified in dBm. The dBm unit describes the logarithmic power ratio to the reference power 1 mW.

Power losses of fibers and splices or connectors are specified in dB.

SIMATIC NET Glass Fiber-Optic Cables

The SIMATIC NET product range for Industrial Ethernet includes various types of glass fiber-optic cables with 62.5/125 µm fibers (see “Passive Components for Optical Networks”).

When connecting SIMATIC NET Industrial Ethernet network components linked with SIMATIC NET glass fiber-optic cables, the maximum length of the link is limited as shown in the table below:

Table 3-1 Maximum length of a link with fiber type G 62.5/125 µm between two optical network components complying with 10BASE-FL (850 nm)

Fiber-Optic Cables	FO power loss At 850 nm	Available budget	Max. length
Standard fiber-optic cable	<=3.1 dB/km	11 dB	3,500 m
INDOOR fiber-optic cable	<=3.5 dB/km	11 dB	3,100 m
Flexible fiber-optic trailing cable	<=3.1 dB/km	11 dB	3,500 m
SIENOPYR duplex FO marine cable	<=3.1 dB/km	11 dB	3,500 m

3.1.2 Industrial Twisted Pair Links

A twisted pair link is limited to a maximum of 100 m. This link can include a maximum of 10 m patch cable (TP Cord). This can be implemented with the following SIMATIC NET twisted-pair cables:

Table 3-2 Max. Cable Lengths with Twisted-Pair Cables

Cable Structure	Cable Type	Max. length	Max. Total of the Patch Cables (TP Cord)
In one piece	ITP standard 2x2 (with sub-D connectors)	100 m	–
Structured	FC standard cable FC trailing cable FC marine cable (connected to RJ-45 FC outlet)	90 m 75 m 75 m	10 m 10 m 10 m

3.1.3 AUI Links

According to the “Ethernet” standard IEEE 802.3 /1/ , a maximum length of 50 m is permitted for AUI links.

Note

When using a CP 1511, the maximum cable length of the AUI link is restricted to 40 m!

3.1.4 Configuring the Entire Network (Collision Domains)

The network span of an Industrial Ethernet network is restricted by the limited signal propagation time required for the CSMA/CD collision mechanism and by the need to maintain a minimum gap between two data packets.

Delay Equivalent

The CSMA/CD collision mechanism of a local area network complying with IEEE 802.3 requires a limited signal propagation time. This means that the physical span of a network (collision domain) is also restricted. Due to the signal propagation time, a maximum of 4520 m is possible between any two DTEs. Each network component has a delay equivalent which means a reduction in the maximum value.

The delay equivalent describes the signal delay caused by a component in the signal path. The value of the signal delay is specified in meters instead of seconds. The value in meters corresponds to the distance that a signal could travel in this time if the signal propagated along a cable instead of through the component. The total of all delay equivalents must be deducted from the overall budget (4520 m). The remainder of the budget is available for cabling of the individual components. In this case, it does not matter whether the cabling is optical fiber, Industrial Twisted Pair, triaxial cable, drop cable etc.

Variability Value and Path Variability Value

In a local area network complying with IEEE 802.3, two data packets must have a certain minimum gap between them. If the gap is smaller, this is known as an interframe gap error.

The variability value of a component describes the fluctuations in the propagation time of a data packet through a network component. If two data packets pass through several network components one after the other, the gap between the packets is reduced. The sum of the values of all components is the Path Variability Value (PVV). The PVV on the path between two DTEs must not exceed 40 bit times (BT); in other words, the gap between packets can be reduced by a maximum of 40 bit times. This value includes a safety margin that includes, among other things, the variability value of the first MAU (Medium Attachment Unit, for example a twisted pair transceiver integrated in the DTE).

By maintaining this maximum value, a minimum gap between the data packets is guaranteed allowing correct recognition of the data packets. The transceiver that is possibly connected to the remote, second DTE does not contribute to the reduction in the interframe gap.

Points to bear in mind when configuring a network:

1. Check your network for critical connection paths. Critical paths are those in which the signal runs through long sections of cable and a lot of network components between two nodes.
2. If you consider a connection path to be critical, check the permitted span (delay equivalents). The sum of the cable lengths between two nodes + the sum of the delay equivalents of the network components between the two nodes must not exceed 4520 m.
3. Check any critical paths to ensure that the maximum path variability values (PVV) are kept to. The sum of the variability values of the network components between to stations must not exceed 40 bit times.
4. For correct configuration complying with IEEE 802.3, all the paths must satisfy these conditions.

Note

When using Industrial Ethernet OSMs/ESMs, the delay equivalent and the path variability value only need to be checked as far as the port of an OSM/ESM, since the collision domain starts and ends here.

3.2 Configuring an Industrial Ethernet Shared LAN

The following components and cables are used in an Industrial Ethernet network:

- Components
  - OLM/ELM
  - Star coupler with interface cards
  - MINI OTDE
- Cables
  - Fiber-optic cables
  - Twisted-pair cable, TP Cord
  - Triaxial cable

3.2.1 Values for Delay Equivalents and Variability Values

To check the two requirements above, you require the values of the delay equivalent and the variable value of each individual component. These are illustrated for the most important components in the tables below.

Optical Link Module (OLM)

Port 1	Port 2	Delay Equivalent	Variability Value
FO	FO	260 m	3 BT
FO	ITP	360 m	6 BT
ITP	ITP	190 m	3 BT

Electrical Link Module (ELM)

Port 1	Port 2	Delay Equivalent	Variability Value
ITP	ITP	190 m	3 BT
AUI	ITP	190 m	3 BT

Optical Star Coupler Cards

Interface Card	Delay Equivalent	Variability Value
ECFL 2	170 m *)	**)
ECFL 4	130 m *)	**)

Electrical Star Coupler Cards

Interface Card	Delay Equivalent	Variability Value
ECAUI	165 m *)	**)
ECTP 3	55 m *)	**)
UYDE	170 m *)	**)

* The specified delay equivalents of the star coupler cards relate to only one port (input or output), in contrast to the calculation for the OLM/ELM. If, for example, there is a change from ECFL2 to ECTP3 at a star coupler, the 170 m of the ECFL2 and the 55 m of the ECTP3 must be added. This also applies when the changeover is between the two ports of the same module, in this case the values of the corresponding interface card must be doubled.

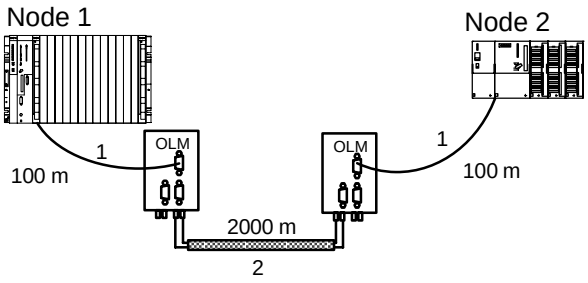
** The variability values of the star coupler cards depend on the combinations of interface cards in the star coupler and are listed in Table 3-3.

Other Components (Transceivers, Fan-Out Units, etc.)

Component	Delay Equivalent	Variability Value
Mini OTDE	100 m	2 BT
Mini UTDE	140 m	2 BT
Transceiver	10 m	3 BT
Repeater	140 m	2 BT
SSV 102 (fan-out unit)		
Port <-> Port	10 m	3 BT
Port <-> Transceiver	5 m	2 BT
SSV 104 (fan-out unit)		
Port <-> Port	15 m	5 BT
Port <-> Transceiver	8 m	4 BT
CP 443-1, CP 343-1, CP 1514, CP 1613		
TP link	140 m	0 BT
AUI link	0 m	0 BT
OSM, ESM		
TP port	210 m	3 BT

Table 3-3 Variability Values in Bit Times (BT) for Interface Card Pairs

	ECFL2	ECFL4	ECTP3	ECAUI	KYDE-S	UYDE
ECFL2	4 BT	4 BT	5 BT	4 BT	4 BT	7 BT
ECFL4	-	3 BT	5 BT	3 BT	3 BT	6 BT
ECTP3	-	-	5 BT	5 BT	5 BT	6 BT
ECAUI	-	-	-	2 BT	2 BT	4 BT
UYDE	-	-	-	–	–	3 BT



1. ITP standard cable 9/15
2. Fiber-Optic Cable (FO)

Figure 3-1 Example of a Simple Configuration

Example of a calculation:

The simple example of a point-to-point link between two DTEs via two OLMs illustrates how to check the network configuration.

Table 3-4 Sample Calculation for Figure 3-1

Node 1 --> Node 2	Cable Length	Delay Equivalent	Variability Value
Node 1		140 m	0 BT
Node 1 - OLM 1	100 m		
OLM 1 (ITP/FO)		360 m	6 BT
OLM 1 - OLM 2	2000 m		
OLM 2 (FO/ITP)		360 m	6 BT
OLM 2 - node 2	100 m		
Node 2		140 m	0 BT
Sum of cable length	2200 m		
Sum of delay equivalents		1000 m	
Totals	**3200 m**		**12 BT**

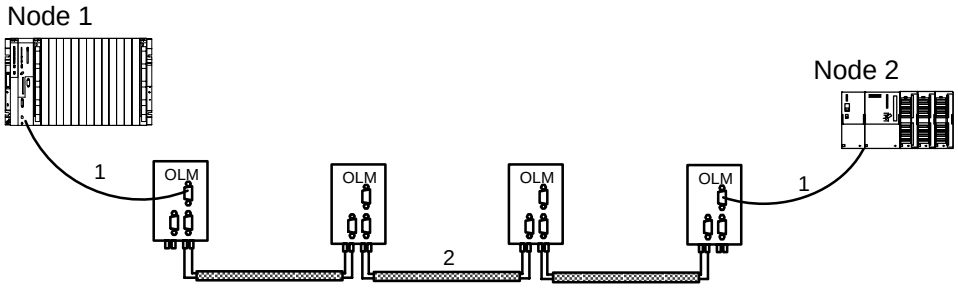
The sum of the cable lengths plus the sum of the delay equivalents add up to 3200 m. The PVV is 12 bit times. This means that the configuration can be implemented.

3.2.2 Bus Structure

The bus structure allows the cascading of OLMs or ELMs in series via fiber-optic cables or twisted pair. A distance of 0 to 3100 m is possible between two link modules connected by optical fiber. With TP cables, a distance of up to 100 m is possible. If a module develops a fault or there is a break on the cable, the network breaks down into two subnets. Within these subnets, problem-free operation remains possible. The advantage of this topology is that large distances can be covered providing the configuration rules are adhered to.

3.2.3 OLM Bus Structure via Optical Fiber

Up to 11 OLMs can be cascaded in series with a remaining cable length of 1180 m providing no further network components exist (refer to the sample calculation).



1. ITP standard cable 9/15
2. Fiber-Optic Cable (FO)

Figure 3-2 Example of an OLM Bus Structure

Sample Calculation (cascading limits)

Number of OLMs	Path Variability Value of Node 1 to Node 2	Total PVV
2	6 BT + 6 BT	12 BT
4	6 BT + 2 * 3 BT + 6 BT	18 BT
8	6 BT + 6 * 3 BT + 6 BT	30 BT
11	6 BT + 9 * 3 BT + 6 BT	39 BT
12	6 BT + 10 * 3 BT + 6 BT	42 BT > 40 BT !!

Number of OLMs	Delay Equivalent from Node 1 to Node 2	Remaining Cable Length
2	140 m + 2 * 360 m + 140 m	3520 m
4	140 m + 360 m + 2 * 260 m + 360 m + 140 m	3000 m
8	140 m + 360 m + 6 * 260 m + 360 m + 140 m	1960 m
11	140 m + 360 m + 9 * 260 m + 360 m + 140 m	1180 m

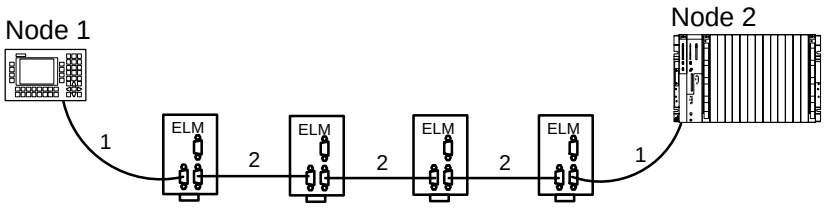
Notes:

- If a DTE is connected via the integrated TP port, this attachment must be included in the length calculation as a delay equivalent of 140 m and a PVV of 0.
- Each further network component increases the PVV and reduces the remaining cable length.

3.2.4 Bus Structure Containing only ELMs

Up to 13 ELMs can be cascaded in series using TP cables providing no further network components exist (see sample calculation).

Cascading ELMs via the ITP Ports



1. ITP standard cable 9/15
2. ITP XP standard cable 9/9

Figure 3-3 Example of a Bus Structure with ELMs via ITP Ports

Sample Calculation (cascading limits)

Number of ELMs	Delay Equivalent from Node 1 to Node 2	Total PVV
2	3 BT + 3 BT	6 BT
4	3 BT + 2 * 3 BT + 3 BT	12 BT
8	3 BT + 6 * 3 BT + 3 BT	24 BT
11	3 BT + 9 * 3 BT + 3 BT	33 BT
12	3 BT + 10 * 3 BT + 3 BT	36 BT
13	3 BT + 11 * 3 BT + 3 BT	39 BT
14	3 BT + 12 * 3 BT + 3 BT	42 BT > 40 BT !!

Number of ELMs	Delay Equivalent from Node 1 to Node 2	Remaining Cable Length
2	140 m + 190 m + 190 m + 140 m	3860 m
4	140 m + 190 m + 2 * 190 m + 190 m + 140 m	3480 m
8	140 m + 190 m + 6 * 190 m + 190 m + 140 m	2720 m
11	140 m + 190 m + 9 * 190 m + 190 m + 140 m	2150 m
12	140 m + 190 m + 10 * 190 m + 190 m + 140 m	1960 m
13	140 m + 190 m + 11 * 190 m + 190 m + 140 m	1770 m

Notes:

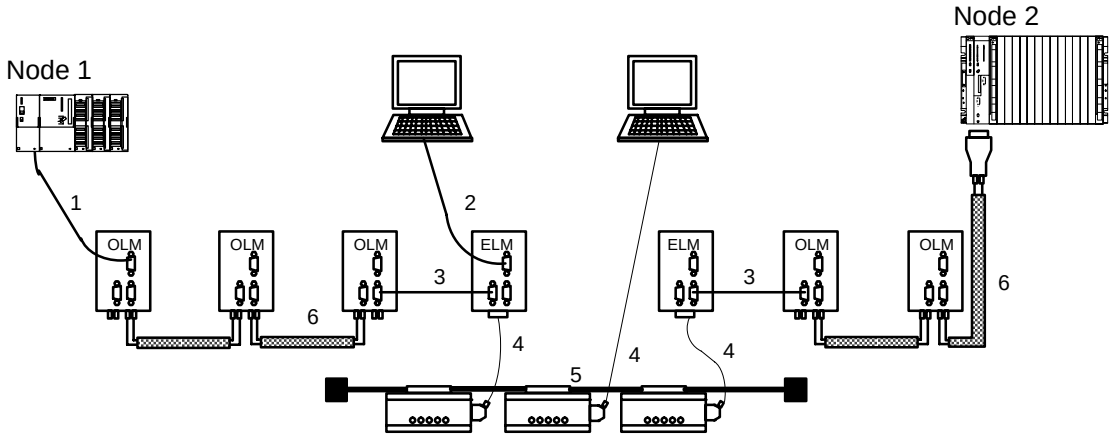
- Each further network component increases the PVV and reduces the remaining cable length.
- When cascading OLMs and ELMs using twisted-pair cables, make sure that you use a crossover cable (cable with XP identifier). This is available in lengths from 2 to 100 meters. For further information and ordering data, refer to the chapter “Passive Components for Electrical Networks”.

3.2.5 Combining OLMs and ELMs in a Bus Configuration

A combined OLM/ELM bus structure is also possible. This allows a connection between an optical network and a triaxial network. The cascading depths that are possible and the remaining cable lengths depend on the modules being used.

Please note that an interconnection on an OLM from optical fiber to TP produces a higher delay equivalent and a higher variability value.

Example:



1. ITP standard cable 9/15
2. TP cord 9/RJ45
3. ITP XP standard cable 9/9
4. 727-1 drop cable
5. Triaxial cable
6. Fiber-optic cable (FO)

Figure 3-4 Example of a Combined OLM/ELM Bus Structure

Checking the example:

Node 1 --> Node 2	Delay Equivalent	Variability Value
Node 1	140 m	0 BT
OLM 1 (ITP/FO)	360 m	6 BT
OLM 2 (FO/FO)	260 m	3 BT
OLM 3 (FO/ITP)	360 m	6 BT
ELM 1 (ITP/AUI)	190 m	3 BT
Transceiver	10 m	3 BT
Transceiver	10 m	3 BT
ELM 2 (AUI/ITP)	190 m	3 BT
OLM 4 (ITP/FO)	360 m	6 BT
OLM 5 (FO/FO)	260 m	3 BT
Mini OTDE	100 m	-
Totals	**2240 m**	**36 BT**
Remaining values	**2280 m**	**4 BT**

The table indicates that the configuration planned in the example is correct and that a cable length of 2280 m remains for networking the components.

Notes:

- Each further network component increases the PVV and reduces the remaining cable length.
- When cascading OLMs and ELMs using twisted-pair, make sure that you use a crossover cable (cable with XP identifier). This is available in lengths from 2 to 100 meters. For further information and ordering data, refer to the chapter “Passive Components for Electrical Networks”.

3.2.6 Redundant Ring Structure with OLMs

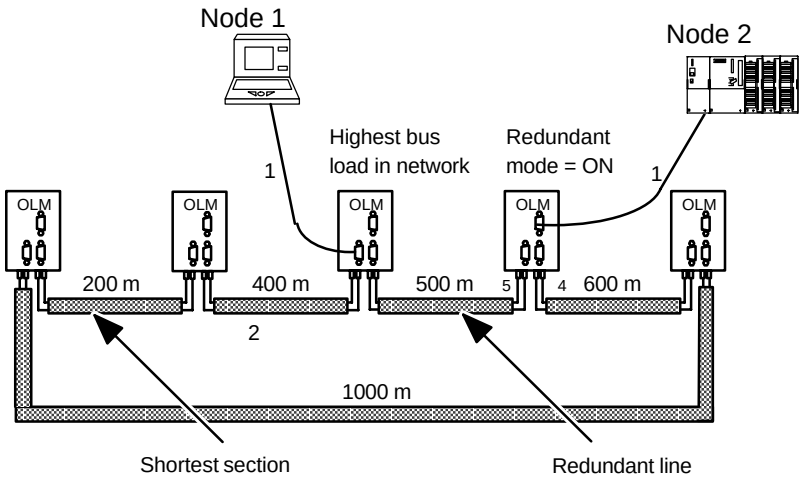
This network topology is a special form of the bus topology. The first and last OLM are connected together via optical fiber and the ring is therefore closed. Port 5 of an OLM within this ring structure must be switched to the redundant mode. The line connected to port 5 then becomes a redundant line that is only used for data transmission when there is a break in the ring. In contrast to a normal bus structure, a ring provides increased availability of the network since the data exchange can be maintained even when an OLM drops out or when the cable is broken and only the sections affected directly by the problem are segmented.

Note

All OLMs in the redundant ring can only be connected to each other by fiber-optic cables.

Configuration Rule

A maximum of 11 OLMs can be cascaded in a redundant ring; in other words, a frame can pass through a maximum of 11 OLMs when being transferred from a sending to a receiving DTE.



1. ITP standard cable 9/15
2. Fiber-optic cable (FO)

Figure 3-5 Example of a Redundant Ring Structure with OLMs

The total cable length includes all the cable lengths in the ring and the cables to the DTEs less the shortest section in the ring (in other words, the worst-case situation if a section breaks down).

Example:

5 OLMs are connected in a redundant ring. 5 OLMs mean that 3020 m remain for the cable length. Each DTE with an integrated TP port is connected via a 100 m TP cable. This means that 2540 m remain for the redundant ring. The sum of the lengths in this example is 200 m + 400 m + 500 m + 600 m + 1000 m = 2700 m, minus the shortest section of 200 m leaves 2500 m. This means that the redundant ring structure has been created according to the configuration rules.

Note on OLM Version 1:

Version 1 OLMs were no longer supplied from the start of 1998 !

To avoid loss of performance in redundant ring structures with OLM version 1 in the redundant mode, you must take into account the load distribution in the network. Follow the steps below:

- Find out which OLM transfers the highest volume of data via its twisted pair ports into the redundant ring.
- Configure the DTEs connected to this OLM so that they take the initiative in establishing layer 4 connections (active connection establishment).
- Set up a connection from this OLM to port 5 of an adjacent OLM and switch this **adjacent** OLM to the redundant mode.

With OLM version 2.0 in the redundant mode, you do not need to take into account the load distribution in the network.
If version 1 and version 2.0 OLMs coexist in a redundant ring structure, there will be less configuration effort involved if you switch the version 2.0 OLM to the redundant mode.

Notes:

- If problems occur implementing a redundant optical ring in practice due to the optical fiber sections being too long, it is possible to get round the problem. To do this, each module is physically connected to the next but one module. At the start and end of a bus connected in this way, the two adjacent modules must be connected to each other (see Figure 3-6).
- All the modules in a ring must be connected over fiber-optic cables.

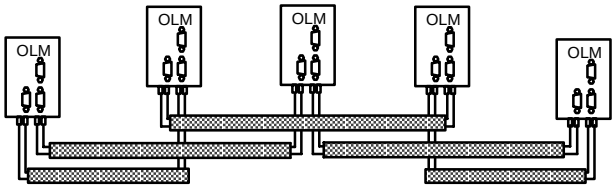


Figure 3-6 Alternative Cabling Technique for a Network Structure with a Redundant Optical Ring Topology

3.2.7 Combinations with Star Couplers and other Network Components

- Optical interface cards ECFL2, ECFL4

  OLMs can be combined with star couplers in an optical network (see Figure 3-7). A bus structure or redundant ring structure can be created with the ECFL2 or ECFL4. The maximum span of the ring depends, in this situation, on the combinations.

- Industrial Twisted Pair interface card ECTP3

  Using the ECTP3, you can attach OSMs/ESMs, OLMs, and ELMs to a star coupler via twisted-pair cables (see Figure 3-7). If you want to cascade modules, use a crossover cable (cable type XP).

- UTP Multiport Repeater interface Card UYDE

  You can connect DTEs using TP Cord or network components such as the OSM, ELM, OLM using TP XP Cord to an ASGE star coupler via the RJ-45 jacks of the UYDE. The UYDE operates according to the 10BASE-T standard at 10 Mbps.

- Mini UTDE electrical transceiver (RJ-45)

  The electrical Mini UTDE RJ-45 transceiver can be plugged in to the AUI interface of DTEs or network components. It converts the AUI port to a twisted-pair port with RJ-45 connector technology.

- MINI OTDE optical transceiver

  The optical transceiver can be plugged into all DTEs that have an AUI port. This allows direct attachment to optical components such as the OLM.

Note

Optical connection of MINI OTDE (10 Mbps) and OSM (100 Mbps) is not possible.

- Transceiver

  ELMs can be attached to a triaxial segment via transceivers and a 727-1 drop cable. Please remember that if the transceiver has two ports and is version 4 or earlier, the attachment must be at the left port.

Whatever configuration is used, the configuration guidelines explained in the previous sections must be adhered to.

Example

The following example once again illustrates how to configure a network when mixing OSMs, OLMs, ELMs, and star couplers. The individual transmission paths must be checked.

Critical paths are those in which the signal runs through long sections of cable and a lot of network components between two nodes.

The connection between node 1 and node 3 represents a critical path. Node 3 is connected to OLM 4 in the redundant ring. In redundant ring structures, make sure that the worst-case situation is assumed for the connection during configuration. This means that a connection that is only used redundantly must also be included although this represents a detour in the normal mode.

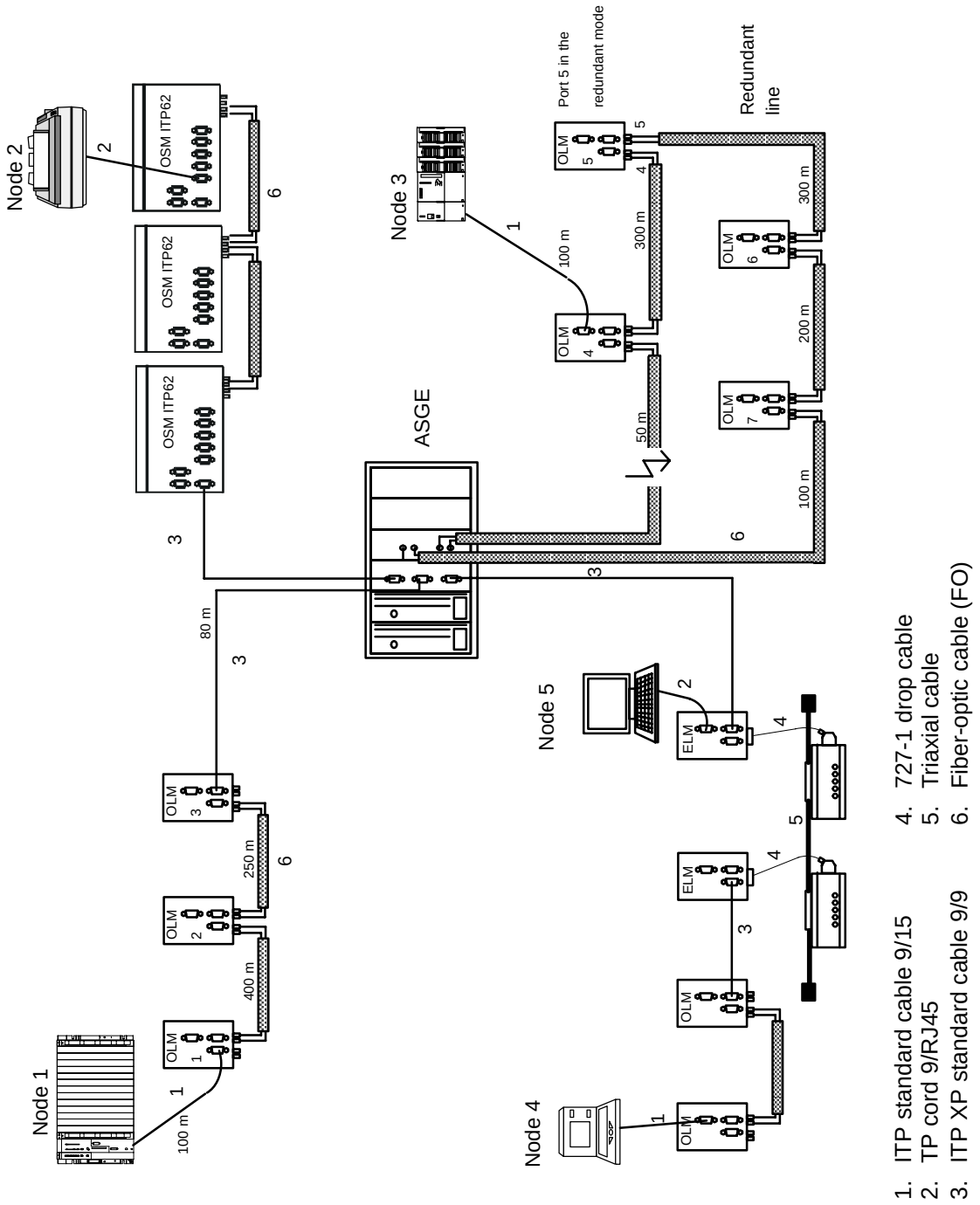


Figure 3-7 Combination of OLMs and Star Couplers

If redundant OLM rings are connected to a star coupler as shown in the example, this ring must be segmented to a worst-case bus. In the example configuration, this means that the line between the star coupler and OLM 4 is interrupted (the lightning strike shown in Figure 3-7). If node 3 on OLM 4 wants to exchange data with node 1 on OLM 1, the route from OLM 4 via OLM 5, 6 and 7 to the star coupler must be calculated.

Note

If redundant rings are attached to a star coupler structure, when checking the configuration, the redundant ring must be segmented to produce a worst-case bus structure. To do this, the shortest connection from the star coupler to one of the two adjacent OLMs is interrupted.

Table 3-5 Checking the Example

Node 1 --> Node 3	Cable Length (as Example)	Delay Equivalent	Variability Value
Node 1		140 m	0 BT
Node 1 - OLM 1	100 m		
OLM 1 (ITP/FO)		360 m	6 BT
OLM 1 - OLM 2	400 m		
OLM 2 (FO/FO)		260 m	3 BT
OLM 2 - OLM 3	250 m		
OLM 3 (FO/ITP)		360 m	6 BT
OLM 3 - ECTP 3	80 m		
ASGE (ECTP3/ECFL2)		225 m	5 BT
ECFL 2 - OLM 7	100 m		
OLM 7 (FO/FO)		260 m	3 BT
OLM 7 - OLM 6	200 m		
OLM 6 (FO/FO)		260 m	3 BT
OLM 6 - OLM 5	300 m		
OLM 5 (FO/FO)		260 m	3 BT
OLM 5 - OLM 4	300 m		
OLM 4 (FO/ITP)		360 m	6 BT
OLM 4 - Node 3	100 m		
Node 3		140 m	0 BT
Sum of cable length	1830 m		
Sum of the delay equivalents		2625 m	
Totals	**4455 m**		**35 BT**

The path between node 1 and node 3 is correctly configured; in other words, all the nodes attached to the redundant ring can exchange data via the star coupler and the line segment connected to ECTP 3.

The same checks must also be performed for other paths (for example node 1 <-> node 4, node 3 <-> node 4). The configuration is only correct when the limit values are not exceeded by any of the paths.

Note

The path of nodes 1, 3, 4 and 5 to node 2 only needs to be checked as far as the first OSM. Due to the way in which the OSM works (“store-and-forward switching”), every collision domain ends at the port of an OSM.

3.3 Switched LANs

Switched Connection Paths

The main feature of switched LANs is that the connection paths for each data packet are switched based on the data destination address. At any point in time, several different data packets can be in transit through the network on different connection paths. The data packets are transported only through segments that lead to the receiver. The products that operate according to the switching method and are therefore used to form switched LANs include the OSM and ESM.

End of the Collision Domain

A further feature of OSMs/ESMs compared with the shared LAN products (OLM and ELM) is that the collision domain ends at the port of an OSM/ESM. In terms of configuration, this means that delay equivalents and path variability values do not need to be checked on connections between OSMs/ESMs.

When structuring the network, you only need to make sure that the permitted maximum lengths of TP and FO cables are not exceeded.

Up to 50 OSMs/ESMs can be cascaded in a ring or bus structure.

3.4 Configuring an Electrical 100 Mbps Switched LAN

Products

The following components and cables are used in a 100 Mbps switched LAN:

- Components
  - Electrical switch module ESM
- Cables
  - Twisted pair cable
  - TP cord

3.4.1 Twisted-Pair Links

100BASE-TX

The twisted-pair ports of the ESM comply with the IEEE 802.3u: 100BASE-TX standard. The connectors are either sub-D-9 or RJ-45 jacks depending on the ESM variant.

Requirements of Twisted Pair Cables

The twisted-pair cables between two adjacent ESMs must not exceed the following maximum lengths:

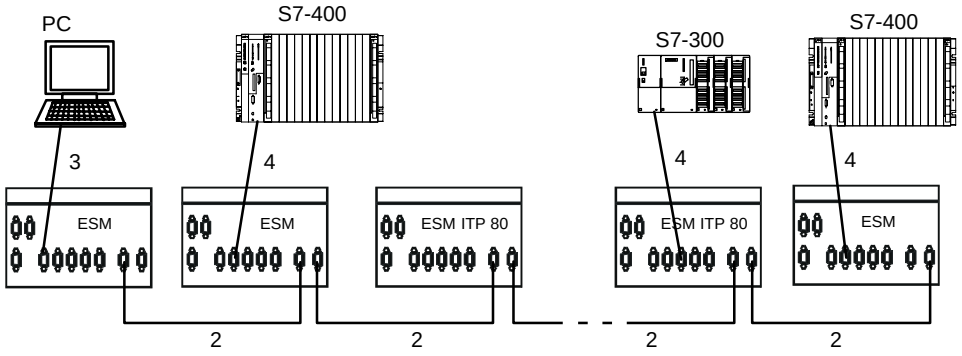
Table 3-6 Max. Cable Lengths with Twisted-Pair Cables

Cable Structure	Cable Type	Max. length	Max. Total of the Patch Cables (TP Cord)
In one piece	ITP standard 2x2 (with sub-D connectors)	100 m	–
Structured	FC standard cable FC trailing cable FC marine cable (connected to RJ-45 FC outlet)	90 m 75 m 75 m	10 m 10 m 10 m

3.4.2 ESM Bus Structure

100 Mbps Switched LAN with a Bus Structure

The Industrial Ethernet ESMs allow the implementation of 100 Mbps switched LANs with a bus structure. The maximum distance between two ESMs must not exceed 100 m. You can cascade the modules to form a bus using any TP port. Up to a maximum of 50 ESMs can be cascaded.



2 ITP XP Standard Cable 9/9

3 TP Cord 9/RJ45

4 ITP Standard Cable 9/15

Figure 3-8 Bus with ESMs

3.4.3 Redundant Ring Structure with ESMs

Redundant Electrical Ring

With the aid of an ESM functioning as the redundancy manager (RM), both ends of an electrical bus made up of ESMs can be closed to form a redundant electrical ring. The ESMs are connected together using ports 7 and 8. The RM monitors the ESM bus connected to it, closes the bus if it detects an interruption and therefore reestablishes a functioning bus configuration.

A maximum of 50 ESMs are permitted in an electrical ring. This allows a reconfiguration time of less than 0.3 s to be achieved. The RM mode is activated on the ESM using a DIP switch.

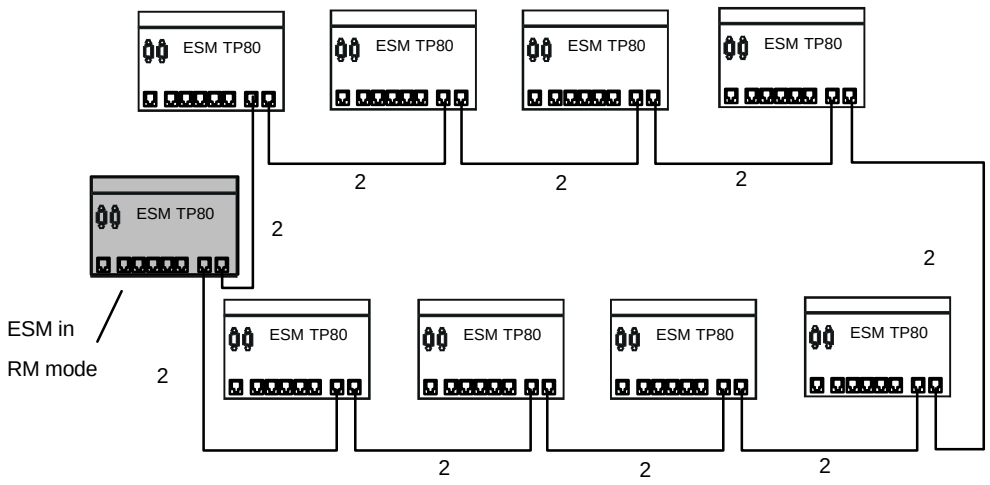
The maximum length of the twisted-pair cable between two ESMs is 100 m. This means that an electrical ring including 50 ESMs can have a maximum span of 5 km.

Note

The reconfiguration time of less than 0.3 s can only be achieved when no components (for example switches from other vendors) other than ESMs are used in the redundant ring.

In a ring, one device and one device only must operate in the redundancy manager mode.

DTEs or complete network segments can be attached to ports 1 – 6 of an ESM operating in the RM mode.



2 Structured cabling with SIMATIC NET twisted pair

Figure 3-9 Redundant Ring Structure with ESMs

3.5 Configuring an Optical 100 Mbps Switched LAN

Products

The following components and cables are used an optical 100 Mbps switched LAN:

- Components
  - OSM (I)TPnn (with multimode glass fiber-optic cable)
  - OSM (I)TPnn-LD (with single mode glass fiber-optic cable)
- Cables
  - Multimode glass fiber-optic cable type 50/125 µm or 62.5/125 µm
  - Single mode glass fiber-optic cable type 10/125 µm
  - Twisted-pair cable, TP Cord

3.5.1 Fiber-Optic Links

The optical ports of the OSMs comply with the IEEE 802.3u standard: 100BASE-FX. They operate at a wavelength of 1300 nm.

Multimode glass fibers of the type 50/125 µm and 62.5/125 µm are suitable for the connection.

To interconnect OSM (I)TPnn-LD (Long Distance Modules), single mode glass fibers of the type 10/125 µm are the most suitable.

The possible length of the fiber-optic link is decided by the following:

- The fiber type multimode / single mode
- The power loss of the fiber at 1300 nm
- The bandwidth distance product of the fiber

Requirements of Multimode Glass Fiber-Optic Cables

Multimode glass fiber-optic cables between two OSM (I)TPnn modules must meet the following requirements in terms of power loss and the bandwidth distance product:

Table 3-7 Max. length of a link with multimode FOCs between two OSM (I)TPnn modules

Fiber Type	FO Power Loss at 1300 nm	Bandwidth Distance Product	Max. length
50/125 µm	<=2.6 dB/km	>= 500 MHz * km	3,000 m
62.5/125 µm	<=1.6 dB/km	>= 500 MHz * km	3,000 m

Requirements of Single Mode Fiber-Optic Cables

Single mode glass fiber-optic cables between two OSM (I)TPnn modules must meet the following requirements in terms of power loss and the bandwidth distance product:

Table 3-8 Maximum length of a link with single mode FOCs between two OSM (I)TPnn-LD modules

Fiber Type	FO Power Loss at 1300 nm	Bandwidth Distance Product	Max. length
10/125 µm	<=2.6 dB/km	>= 500 MHz * km	26,000 m

SIMATIC NET Multimode Glass Fiber-Optic Cables

The SIMATIC NET product range for Industrial Ethernet includes various types of multimode glass fiber-optic cables with 62.5/125 µm fibers (see “Passive Components for Optical Networks”).

- INDOOR fiber-optic cable
- Fiber-optic standard cable
- Flexible fiber-optic trailing cable
- SIENOPYR duplex marine fiber-optic cable

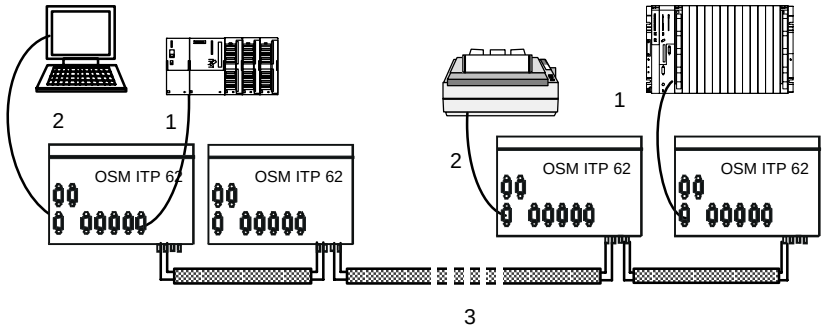
When connecting SIMATIC NET Industrial Ethernet OSMs using SIMATIC NET multimode glass fiber-optic cables, distances of 0 to 3000 m are permitted between two adjacent components.

Note

Single mode glass fiber-optic cables with fiber type 10/125 µm are available in customized lengths. You will find the person to contact in the ”Support and Training” section of this manual.

3.5.2 OSM Bus Structure

The Industrial Ethernet OSMs allow the implementation of 100 Mbps switched LANs with a bus structure. The maximum distance between 2 OSMs is 3000 m or 26 km for the LD variant. Modules are cascaded using the FO ports. Up to 50 OSMs can be cascaded.



1. ITP standard cable 9/15
2. TP cord 9/RJ-45
3. Fiber-optic cable (FO)

Figure 3-10 OSM Bus Structure

3.5.3 Redundant Ring Structure with OSMs

Redundant Optical Ring

With the aid of an OSM functioning as the redundancy manager (RM), both ends of an optical bus made up of OSMs can be closed to form a redundant optical ring. The OSMs are connected together using ports 7 and 8. The RM monitors the OSM bus connected to it, closes the bus if it detects an interruption and therefore reestablishes a functioning bus configuration.

A maximum of 50 OSMs are permitted in an optical ring. This allows a reconfiguration time of less than 0.3 s to be achieved. The RM mode is activated on the OSM using a DIP switch.

The maximum length of the fiber-optic cable between two OSMs is 3,000 m. This means that an optical ring including 50 OSMs can have a maximum span of 150 km.

Note

The reconfiguration time of less than 0.3 s can only be achieved when no components (for example switches from other vendors) other than OSMs are used in the redundant ring.

In a ring, one device and one device only must operate in the redundancy manager mode.

DTEs or complete network segments can be attached to ports 1 – 6 of an OSM operating in the RM mode.

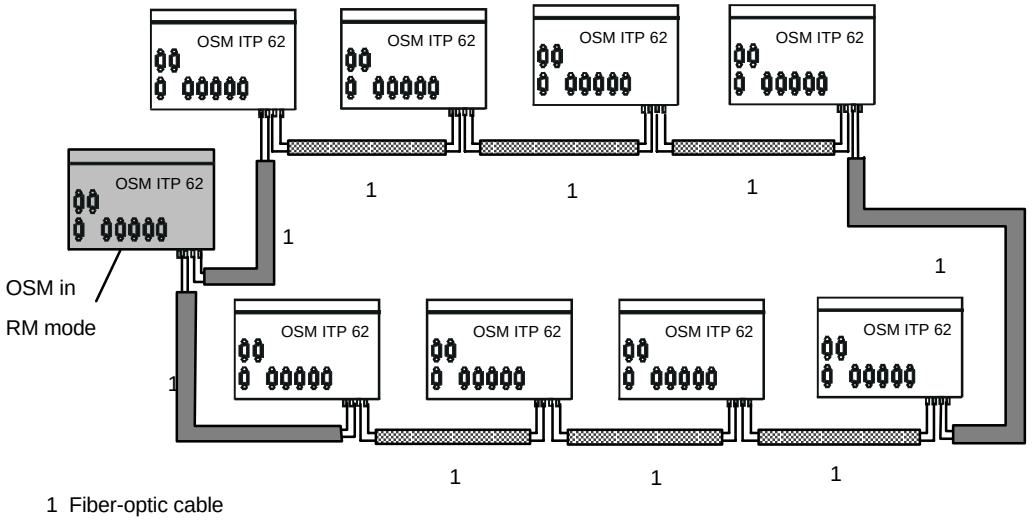


Figure 3-11 Redundant Ring Structure with OSMs

3.6 Redundant Linking of Network Segments with OSMs/ESMs

Standby-Sync Port

The standby-sync port allows the connection of two Industrial Ethernet OSMs or ESMs with one operating as standby master (DIP switch ”Stby off”) and the other as standby slave (DIP switch ”Stby on”). With this mode, pairs of OSMs/ESMs can be used for redundant coupling of OSM/ESM or OLM rings.

With network management, the OSM/ESM can also be configured so that several rings or networks can be interconnected at the same time with two OSMs/ESMs (see OSM/ESM Network Management, Manual /8/).

Synchronization Cable

The redundant connection between two network segments is on two separate paths. The standby-sync ports of the two OSMs/ESMs used for the redundant link are interconnected by a synchronization cable. The cable used for this is a TP-XP Standard Cable 9/9 with a maximum length of 40 m. The two OSMs/ESMs inform each other of their operating states via this synchronization cable. One of these OSMs/ESMs is assigned the redundant function using the DIP switch setting ”Stby on” (standby slave). The other OSM takes over the function of the standby master (DIP switch setting ”Stby off”).

Immediately following the failure of the main transmission path, the standby slave enables the redundant path. If the main path is OK again, the standby master informs the standby slave. The main path is enabled and the redundant path disabled again. The reconfiguration time of the redundant ring coupling is less than 0.3 s.

Port Assignment in the Standby Mode

On the standby master and standby slave, only port 1 (standby port) can be used for the coupling to the neighboring ring. Ports 2 – 6 can be used just as normal OSM ports.

The port assignment is the default setting of an OSM when shipped.

With network management, it is also possible to configure ports other than port 1 or several ports as standby ports (see also OSM/ESM Network Management Manual /8/).

Simultaneous Standby and Redundancy Manager Operation

A standby master or standby slave can act as redundancy manager in a redundant ring at the same time.

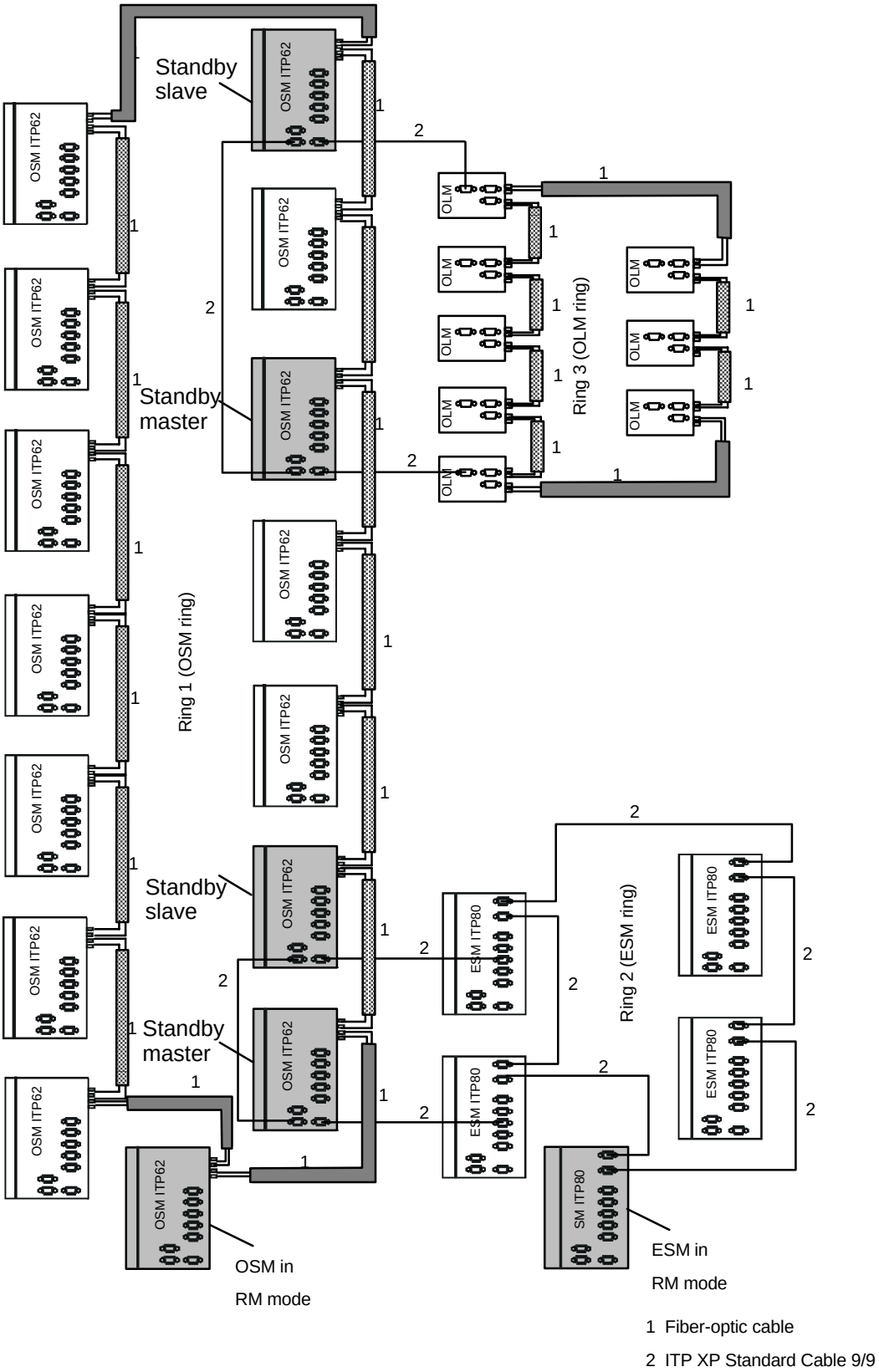


Figure 3-12 Redundant Coupling of Network Segments

Passive Components for Electrical Networks

4

Chapter Overview

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4.1 Overview of Twisted-Pair Cables

This chapter describes the technical properties of Industrial Twisted Pair and twisted-pair cables. First, the unassembled cable types are described followed by the available preassembled cables.

ITP (Sub-D Connectors)

To establish a direct link between nodes and network components, the ITP Standard Cable preassambled with robust sub-D male connectors is available.

This allows a cable length of up to 100 m without patch cables.

FC Twisted-Pair

For structured cabling within a factory, the FC twisted-pair cabling system is ideal. Using the FastConnect (FC) system for Industrial Ethernet, structured cabling from the office environment has been further developed for use in the factory.

Connectors can be fitted to the FastConnect cables quickly on site. As a result, the RJ-45 cabling technology as an existing standard is now also available for an industrial environment allowing structured cabling (patch cables, patch panel, installation cables, outlets, outlet cables).

Guidelines for Laying Cables

You will find information about laying SIMATIC NET twisted-pair cables in Section 7.7 in this manual.

Structured Cabling

Structured cabling complying with EN 50173 describes the tree-structured cabling of building complexes for information technology purposes regardless of the applications used. A building is divided into the following areas:

- Primary area
  (interconnection of buildings of a campus)
- Secondary area
  (interconnection between floors of a building)
- Tertiary area (information technology connectors for the DTEs of a floor)

The structured cabling that can be implemented with the Industrial Ethernet FastConnect system complies with the tertiary cabling described in EN 50173.

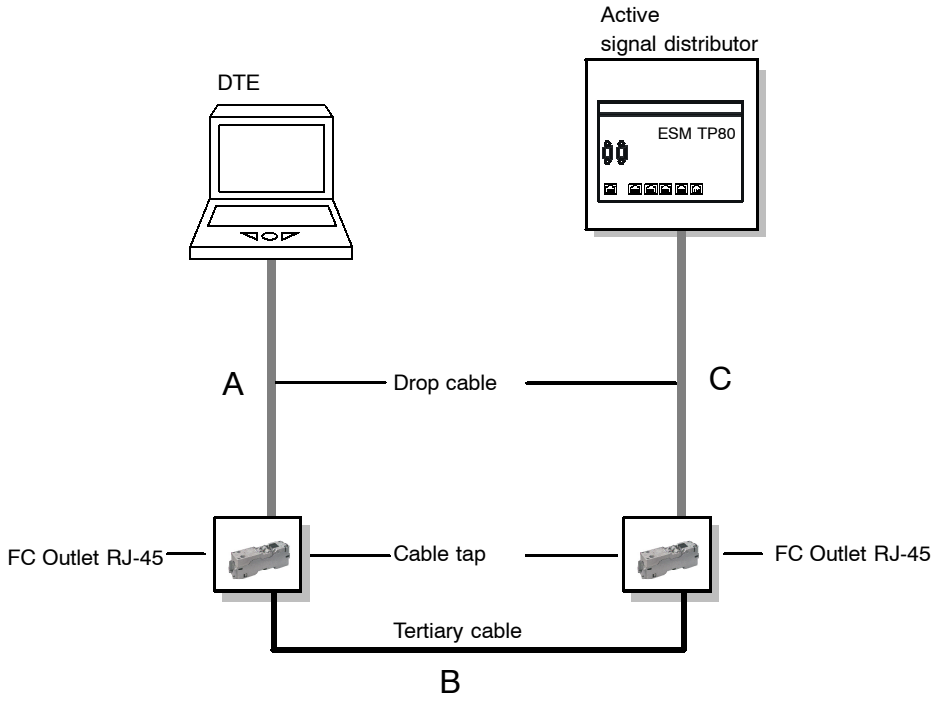


Figure 4-1 System Configuration with FC Outlet RJ-45

Maximum Cable Lengths

Table 4-1 Structured Cabling Complying with EN 50173

Uses	SIMATIC NET Cable	Maximum Length
Drop cable	TP cord	A+C max. 10 m
Tertiary cable	FC TP Standard Cable FC TP Trailing Cable FC TP Marine Cable	B max. 90 m B max. 75 m B max. 75 m

Note

Industrial Twisted Pair cables (TP Standard Cable) are intended for use inside buildings.

Twisted-pair cables (TP Cord) are intended for use in areas where EMI levels are low such as in an office or a wiring closet.

4.2 Industrial Twisted Pair Standard Cable

Structure of the Standard Cable

The standard cable is designed as a 100 Ω S/STP cable (screened/shielded twisted pair) with two pairs of wires. The basic element consists of two twisted wires along with two blind elements, known as a twisted pair.

The wires are solid copper covered by an insulation layer of cellular polyethylene which is further covered by a non-cellular foam skin. The color coding of the conductors can be seen in Table 4-2. The cables have an outer sheath of green PVC.

Table 4-2 Color Coding of the Pairs

Pair	1	2
Conductor a	white	white
Conductor b	blue	orange

Shielding

Each pair of wires is shielded by two plastic laminated aluminum foils with an external contact surface. All the pairs making up the cable are surrounded by a braided shield of tin-plated copper wires (coverage approximately 90%).

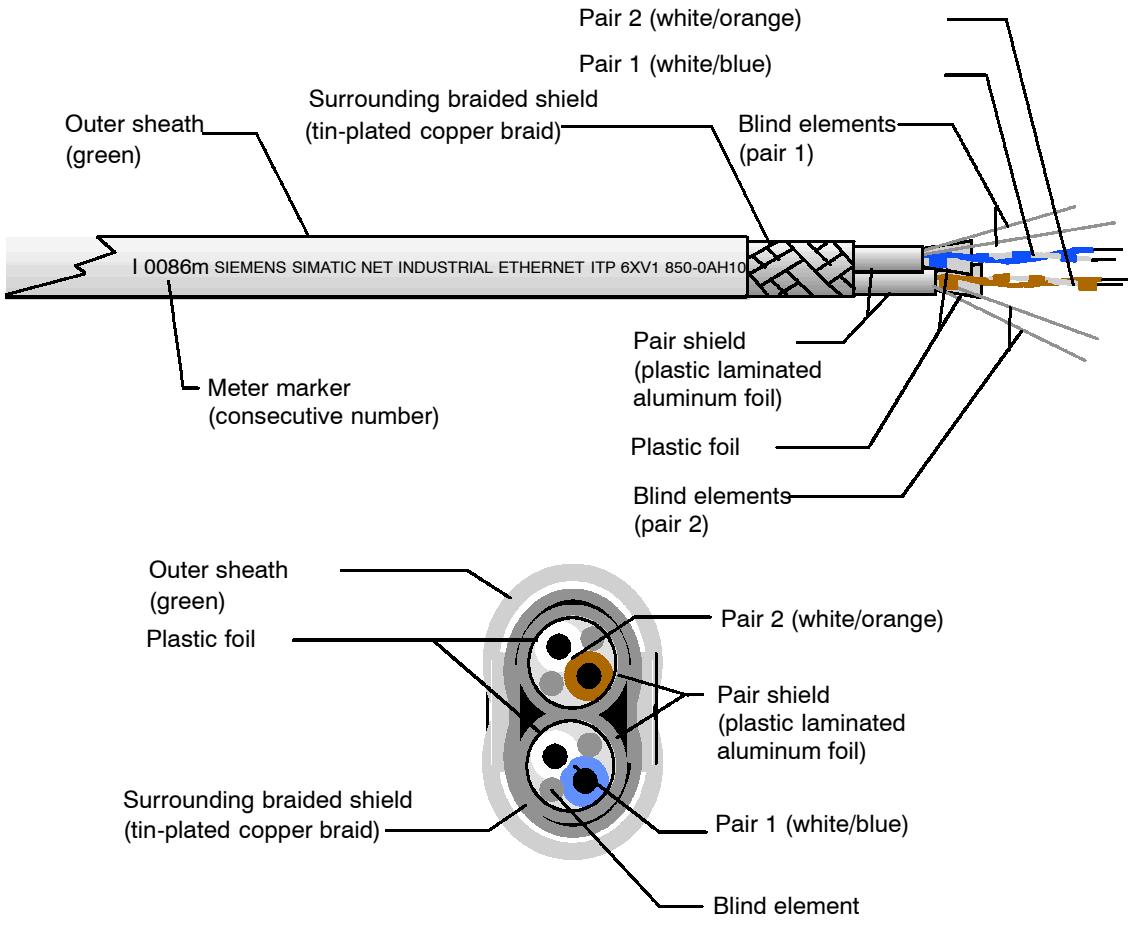


Figure 4-2 Structure of the Two-Pair Industrial Twisted Pair Standard Cable

Labeling

The standard cable is labeled as follows:
”SIEMENS SIMATIC NET INDUSTRIAL ETHERNET ITP”.

If the cable is supplied without connectors, the label above is followed by the order number “6XV1850-0AH10”.

There are also markers at one meter intervals. These make it simple to check the length of the cable.

Technical Specifications

Table 4-3 Electrical Data of the ITP Standard Cable at 20 °C

Cable categories complying with EN 50173	CAT5		
DC loop resistance		maximum	124 Ω/km
DC insulation resistance		minimum	5 GΩ x km
Attenuation/100 m	at 4 MHz 10 MHz 100 MHz	maximum	3.6 dB 5.7 dB 18.0 dB
Near end crosstalk loss (NEXT)/100 m	at 1 to 300 MHz	minimum	80 dB
Characteristic impedance	at 1 to 100 MHz 100 to 300 MHz		100 Ω ±15% 100 Ω +45/-30%
Transfer impedance	at 10 MHz	maximum	2 mΩ/m
Structural return loss	at 1 to100 MHz 100 to 300 MHz	minimum	23 dB 15 dB
Longitudinal conversion loss		minimum	43 dB
Capacitance unbalance pair to ground		maximum	3400 pF/km
Dielectric strength at 50 Hz - conductor/conductor - conductor/shield	 1 min 1 min	effective value	 700 V 700 V

Table 4-4 Mechanical Data of the ITP Standard Cable

Standard code	J-02YSCY 2x2x0,64/1,5 PIMF F GN
∅ Conductor	0.64 mm
∅ Outer (approx.)	(9.2x6 ± 0.5) mm
Approximate thickness of the outer sheath	0.8 mm
Bend radius: Multiple bends Single bend	 Over the flat side ≥ 45 mm ≥ 30 mm
Tensile strength	≤80 N
Pressure load	Maximum permitted load: 5 kN/10 cm Test complying with IEC 794-1 E3
Temperature range: Operation Installation/assembly Transport/storage	 -40 °C...70 °C - 5 °C...50 °C -40 °C...70 °C
Copper weight	46 kg/km
Net weight	90 kg/km
Free of halogens	no
Resistance to fire	Flame-retardant complying with DIN VDE 0472, Part 804 test type B and IEC 60332-1
Resistance to oil	Resistant to mineral oils and fats complying with VDE 0472 Part 803

Notes on Installation

The maximum total length of a segment is 100 m. To obtain the best transmission characteristics, the segment should consist of one single section of cable. In special situations (for example when passing through two closets), the segment can consist of up to three separate sections of cable.

The excellent transmission characteristics of the entire system can be guaranteed only when SIEMENS Industrial Ethernet network components are used exclusively.

Assembling Cables with Twisted-Pair Sub-D Connectors
When assembling Industrial Twisted Pair cables yourself, make sure that you only combine the Industrial Twisted Pair standard cable 2x2 with the SIMATIC NET Industrial Twisted Pair sub-D connector for assembly on site. The dimensions of these two components match each other.

Do Not Connect to FC Outlet RJ-45
The Industrial Twisted Pair standard cable 2x2 is not suitable for connection to the FC Outlet RJ-45 due to its diameter. Use FastConnect (FC) twisted-pair cables for connection to the FC Outlet RJ-45.

Versions Available

The two-pair standard cable is available as a preassembled cable with 9-pin or 15-pin sub-D connectors or can be ordered without connectors in meters.

The following preassembled cables use Industrial Twisted Pair standard cable:

- ITP standard cable 9/15
- ITP XP standard cable 9/9
- ITP XP standard cable 15/15

4.3 FastConnect (FC) Twisted-Pair Cables

General

When installing Industrial Ethernet networks, there are various cable types available for different applications.

The Industrial Ethernet FC cables listed should be used.

The symmetrical radial structure of the FastConnect (FC) twisted-pair cables allows the use of the IE FC stripping tool. With this tool, connecting to the FC Outlet RJ-45 is fast and simple.

Design

The FastConnect (FC) twisted-pair cable is a shielded cable with a symmetrical radial design and 100 Ω characteristic impedance. The cable consists of 4 conductors arranged as a star quad.

The FC TP Standard Cable has solid cores, the FC TP Trailing Cable and the FC TP Marine Cable have stranded cores.

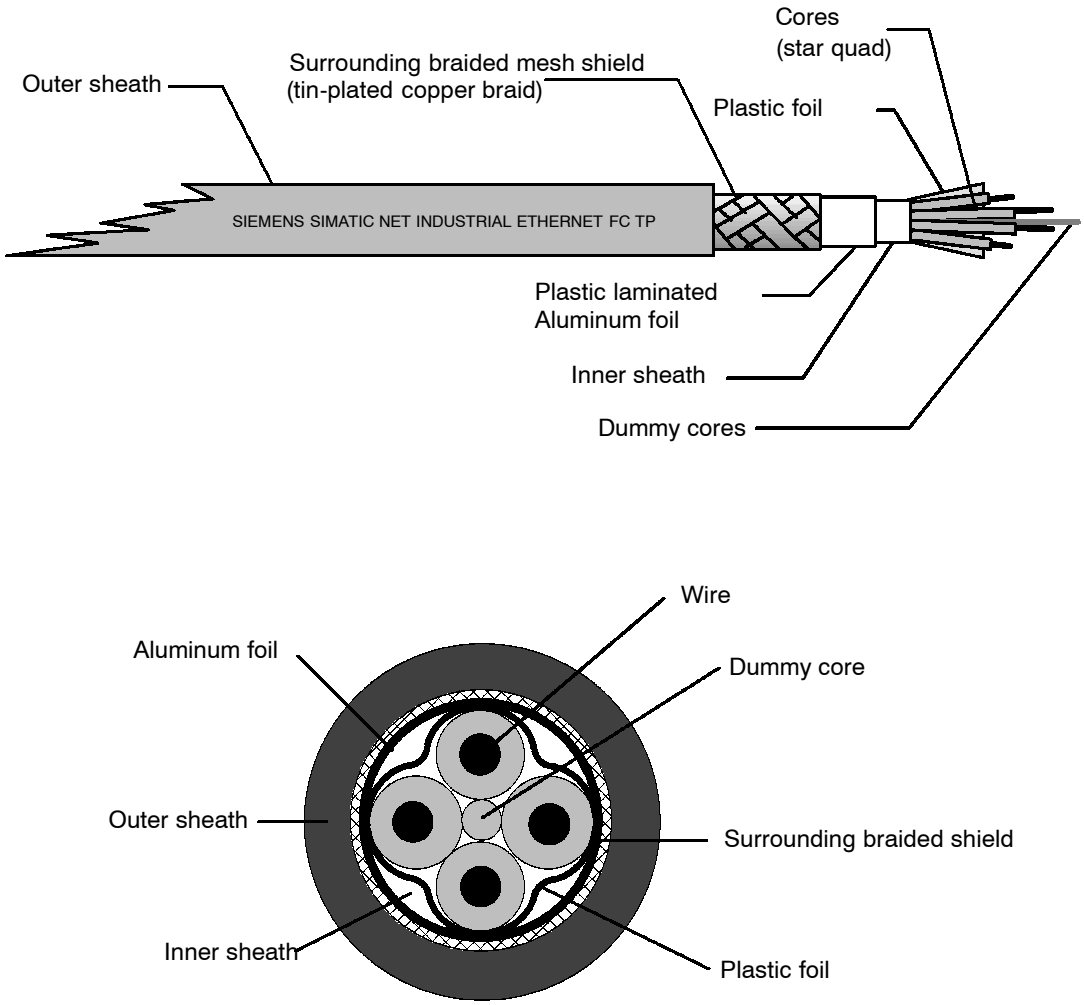


Figure 4-3 Cross Section of the FastConnect (FC) Twisted-Pair Cable

Technical Specifications

Table 4-5 Electrical Specifications of the FastConnect (FC) Twisted-Pair Cables

Cable Type [1]	**Industrial Ethernet FC TP Standard Cable**	**Industrial Ethernet FC TP Trailing Cable**	**Industrial Ethernet FC TP Marine Cable**
Areas of application	Universal application	Use in drag chains	Marine and offshore applications [2]
Electrical Data at 20 °C			
Attenuation at 10 MHz at 100 MHz	 ≤ 6.5 dB/100 m ≤ 22.0 dB/100 m	 ≤ 7.8 dB/100 m ≤ 26.4 dB/100 m	 ≤ 7.8 dB/100 m ≤ 26.4 dB/100 m
Characteristic impedance at 1-100 MHz	 100 Ω ±15% Ω	 100 Ω ± 15% Ω	 100 Ω ± 15% Ω
Near end crosstalk loss at 1-100 MHz	 ≥ 35 dB/100 m	 ≥ 35 dB/100 m	 ≥ 35 dB/100 m
Transfer impedance at 10 MHz	 ≤ 10 mΩ/m	 ≤ 10 mΩ/m	 ≤ 10 mΩ/m
DC loop resistance	≤ 124 Ω/km	≤ 120 Ω/km	≤ 120 Ω/km
DC insulation resistance	> 500 MΩ x km	> 500 MΩ x km	> 500 MΩ x km

1) Electrical properties at 20 °C, tested according to DIN 0472
2) Ship building approvals:
   - Germanischer Lloyd
   - Lloyds Register of Shipping
   - Bureau Veritas
   - Det Norske Veritas
   - ABS Europe LTD

Table 4-6 Mechanical Specifications of the FastConnect (FC) Twisted-Pair Cables

Cable Type	**Industrial Ethernet FC TP Standard Cable**	**Industrial Ethernet FC TP Trailing Cable**	**Industrial Ethernet FC TP Marine Cable**
Cable type (standard code)	2YY (ST) CY 2x2x0.64/1.5-100 GN	2YH (ST) C11Y 2x2x0.75/1.5-100 LI VZN GN FRNC	L-9YH (ST) CH 2x2x0,34/1.5-100 GN VZN FRNC
Inner core ∅ (copper)	0.64 mm	0.75 mm	0.75 mm
Insulation	PE ∅ 1.5 mm	PE ∅ 1.5 mm	PP ∅ 1.5 mm
Inner sheath	PVC ∅ 3.9 mm	FRNC ∅ 3.9 mm	FRNC ∅ 3.9 mm
Outer sheath	PVC ∅ (6.5 ± 0.4) mm	PVC ∅ (6.5 ± 0.2) mm	FRNC ∅ (6.5 ± 0.4) mm
Environmental conditions - Operating temperature - Transport/storage temperature - Installation temperature	 −40 °C to +70 °C −40 °C to +70 °C −20 °C to +60 °C	 −40 °C to +70 °C −50 °C to +70 °C −20 °C to +60 °C	 −25 °C to +70 °C −40 °C to +70 °C 0 °C to +50 °C
Permitted bend radius multiple single	 8 x ∅ 5 x ∅	 8 x ∅ 5 x ∅	 8 x ∅ 5 x ∅
Bending cycles	–	5 million 3)	–
Permitted tensile stress	≤ 150 N	≤ 150 N	≤ 150 N
Weight approx.	70 kg/km	63 kg/km	68 kg/km
Free of halogens	no	yes	yes
Behavior in fire	Flame retardant to IEC 332-1	Flame retardant to IEC 332-1	Flame retardant to IEC 332-3 Cat.A/F
Resistance to oil	Cond. oil resistant	Cond. oil resistant	Cond. oil resistant
UL listed	yes	yes	yes
UV resistance	yes	yes	yes

3) at a bent diameter of 200 mm

Application

- FC TP Standard Cable:
  Standard bus cable specially designed for fast assembly.
- FC TP Trailing Cable:
  Bus cable for special applications with forced movement in a drag chain; for example with permanently moving machine parts (stranded cores, halogen-free).
- FC TP Marine Cable:
  Bus cable specially for use on ships (stranded cores, halogen-free, certified for ship building).

Advantages

- For structured cabling in the factory
- Time-saving due to simple and fast installation with FastConnect cables and the Industrial Ethernet FC Outlet RJ-45
- Specific versions for different applications
  - FC TP Standard Cable
  - FC TP Trailing Cable
  - FC TP Marine Cable
- High noise immunity due to double shielding
- Easy length measurement with printed meter markers
- Exceeds the requirements of category 5 of the international cabling standards ISO/IEC 11801 and EN 50173

Notes on Installation

The bus cables are sold in meters.

FastConnect
Using the Industrial Ethernet FastConnect stripping tool, the outer jacket and shield of Industrial Ethernet FastConnect cables can be stripped to correct lengths in a single action. This allows the Outlet RJ-45 to be connected quickly and simply to the Industrial Ethernet FC cable.

Note the reduced maximum length for FC TP Trailing and FC TP Marine Cable
Due to the stranded cores used in the two special cables FC TP Trailing Cable and FC TP Marine Cable, the signal attenuation is higher. To avoid exceeding the maximum permitted attenuation of a transmission link, the maximum distance between two FC Outlet RJ-45 taps for FC TP Trailing Cable or FC TP Marine Cable is 75 m.

Do not use with twisted-pair sub-D connectors
FastConnect twisted-pair cables are not suitable for the use of Industrial Twisted Pair sub-D connectors due to their diameter. If you assemble Industrial Twisted Pair cables yourself with sub-D connectors, use only Industrial Twisted Pair standard cable!

Laying Cables
During storage, transport, and installation, the bus cable must be closed at both ends with a shrink-on cover. Make sure that you do not exceed the bend radii and tensile stress!

Ordering Data

Table 4-7

	Order number
Industrial Ethernet FC TP Standard Cable TP installation cable for attachment to Industrial Ethernet FC Outlet RJ-45 for universal application, 4-wire, shielded, sold in meters, maximum length available 1000 m, minimum length 20 m.	**6XV1 840-2AH10**
Industrial Ethernet FC TP Trailing Cable TP installation cable for attachment to the Industrial Ethernet FC Outlet RJ-45 for use in a drag chain, 4-wire, shielded, maximum length available 1000m, minimum length 20m.	**6XV1 840-3AH10**
Industrial Ethernet FC TP Marine Cable TP installation cable for attachment to Industrial Ethernet FC Outlet RJ-45, approved for ship building, 4-wire, shielded, maximum length available 1000m, minimum length 20m.	**6XV1 840-4AH10**
Industrial Ethernet FC Stripping Tool Preset insulation stripping tool for fast stripping of Industrial Ethernet FC cables	**6GK1 901-1GA00**
Industrial Ethernet FC Blade Cassettes Cassette with spare blades for the Industrial Ethernet Stripping Tool, set of 5	**6GK1 901-1GB00**
Industrial Ethernet FC Outlet RJ-45	**6GK1 901-1FC00-0AA0**

4.4 Twisted-Pair Cord

General

The TP Cord is used to attach DTEs to the Industrial Ethernet FC cabling system. It is intended for use in an environment with low levels of noise, such as in an office or within wiring closets.

To distinguish between crossover and straight through cables, the RJ-45 connectors are color-coded. On crossover cables, the RJ-45 connectors are red at both ends, on straight through cables, the RJ-45 connectors are green at both ends.

A maximum of 10 m of twisted-pair cord can be used between two devices. With structured cabling using two TP Cord cables, the two patch cables together must not exceed this length.

Adapter cables are used to connect devices with a sub-D port to devices with an RJ-45 port.

The TP port converter is used to connect a DTE with an RJ-45 interface to the Industrial Twisted Pair cabling system.

Design

The cable consists of two pairs of wires each pair twisted together (PIMPF structure). Each pair is shielded with an aluminum foil. The outer shield is a tin-plated copper braid mesh. The outer sheath is PVC.

Shielding

Each pair of wires is shielded by two plastic laminated aluminum foils with an external contact surface. All the pairs making up the cable are surrounded by a braided shield of tin-plated copper wires (coverage approximately 88%).

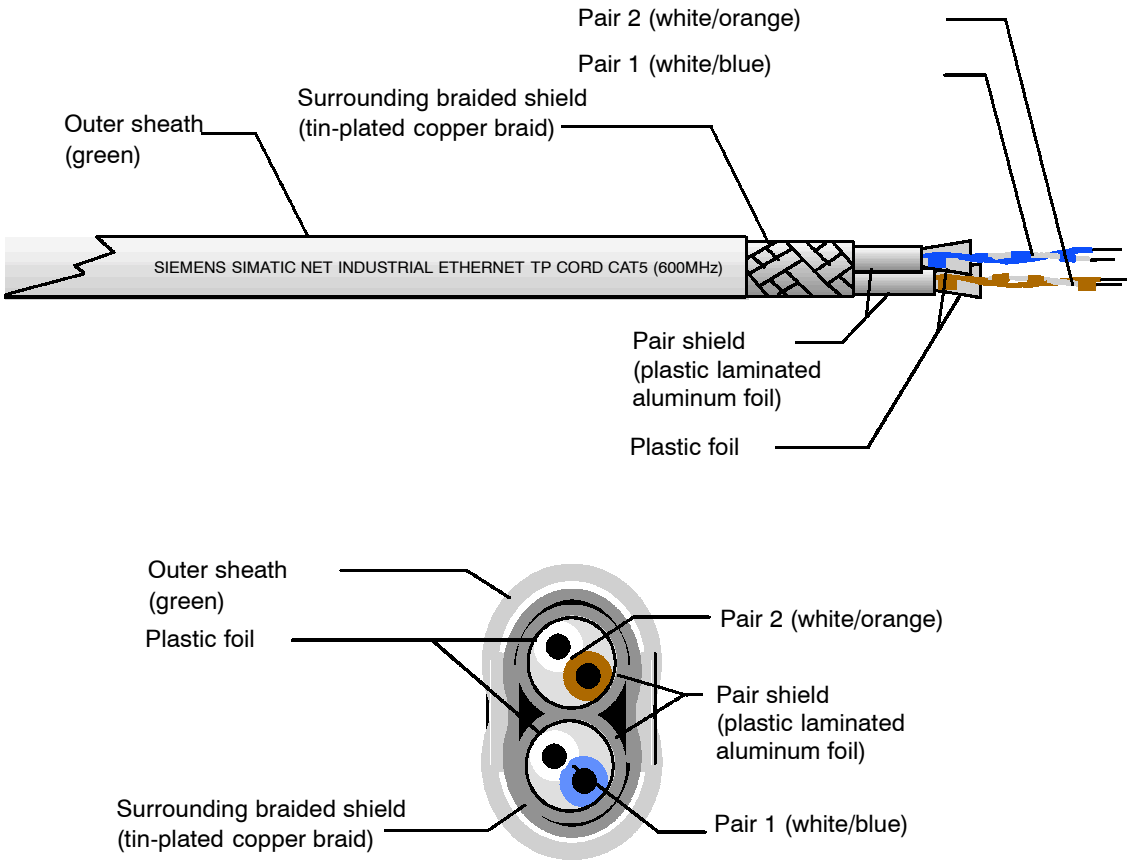


Figure 4-4 Structure of the two-pair TP Cord (PIMF)

Labeling

The TP Cord is labeled as follows:
”SIEMENS SIMATIC NET INDUSTRIAL ETHERNET TP CORD CAT5 (600MHz)”.

Technical Specifications

Table 4-8 Electrical Data of the Twisted-Pair Cord at 20ºC

Cable category (EN 50173)	CAT5			
DC loop resistance			maximum	300 Ω/km
DC insulation resistance			minimum	150 MΩ x km
Attenuation/100 m	at	4 MHz	maximum	5.7 dB
		10 MHz		9.0 dB
		100 MHz		28.5 dB
Near end crosstalk loss (NEXT)/100 m	at	4 MHz	minimum	80.0 dB
		10 MHz		80.0 dB
		100 MHz		72.5 dB
Char. impedance	at	1 to 100 MHz		100 Ω±15%
Transfer impedance	at	10 MHz	maximum	10 mΩ/m
Structural return loss	at	1 to 20 MHz	minimum	23 dB
		20 to 100 MHz		23 dB – 10log(f/20)
Longitudinal conversion loss			minimum	43 dB
Capacitance unbalance pair to ground	at	1 kHz	maximum	1600 pF/km
Dielec. strength at 50 Hz			effective value	
–conductor/conductor		1 min		700 V
– conductor/shield		1 min		700 V

Table 4-9 Mechanical Data of the Twisted-Pair Cord

Standard code	LI02YSCY 2x2x0,15/0.98 PIMF GN
∅ Copper wire	0.5 mm
Outer dimensions	approx. 3.7 x 5.8 mm
Thickness of the outer sheath	approx. 0.5 mm
Bend radius: single bend multiple bends	 ≥ 20 mm over the narrow side ≥ 30 mm over the narrow side
Tensile strength:	≤ 48 N
Temperature range: Operation Installation/assembly Transport/storage	 -40 °C...70 °C -20 °C...50 °C -40 °C...70 °C
Net weight	33 kg/km
Free of halogens	no
Resistance to fire	Flame-retardant to DIN VDE 0472, Part 804 test type B

Versions Available

The following preassembled cables use TP cord:

- TP Cord RJ-45 / RJ-45 with 2 RJ-45 connectors
- TP XP Cord RJ-45 / RJ-45 with 2 RJ-45 connectors (crossover)
- TP cord 9/RJ-45 with one 9-pin sub-D and one RJ-45 connector
- TP cord 9 / RJ-45 with one 9-pin sub-D and one RJ-45 connector (crossover)
- TP Cord 9 -45 / RJ-45 with one 9-pin sub-D male connector (45° cable outlet) and one RJ-45 connector
- TP XP Cord 9-45/ RJ-45 with one 9-pin sub-D male connector (45° cable outlet) and one RJ-45 connector (crossover)
- TP cord 9 / RJ-45 with one 9-pin sub-D and one (crossover)
- TP Cord RJ-45/15 with one 15-pin sub-D and one RJ-45 connector
- TP XP Cord RJ-45/15 with one 15-pin sub-D and one RJ-45 connector (crossover)

4.5 Preassembled Industrial Twisted Pair (ITP) and Twisted-Pair (TP) Cables

Use of Preassembled Cables

Preassembled SIMATIC NET cables are available to connect DTEs and network components.

Industrial Twisted Pair (ITP) Cables

Preassembled Industrial Twisted Pair cables are intended for direct links (without patch cables) of up to 100 m in length between two devices.
Due to the double, extra thick shielding, Industrial Twisted Pair cables are particularly suitable for an industrial environment with high levels of EMI, for example for a connection between wiring closets.

Twisted-Pair (TP) Cables (Cord)

The flexibility of the cord cables allows simple installation, for example in a wiring closet or to connect devices in a control room with low EMI levels.
A maximum of 10 m of twisted-pair cord can be used between two devices. With structured cabling using two twisted-pair patch cables, this length is maximum for both patch cables together.
Adapter cables are used to connect devices with a sub-D port to devices with RJ-45 port.

To convert the RJ-45 interface of a DTE to a 15-pin sub-D interface of the ITP cabling system, you can use the TP converter cord 15/RJ-45.

Note

Other special cables and special lengths are available on request. You will find a contact address in Appendix B.

4.5.1 Preassembled Industrial Twisted Pair Cables

General

Preassembled Industrial Twisted Pair cables use the sturdy 9 or 15-pin sub-D connectors on an ITP standard cable. These cables have the additional “ITP” marking. These cables require DTEs and network components with Industrial Twisted Pair ports.

The connection between an active network component and the DTE is established with an Industrial Twisted Pair cable with a 9-pin (network component end) and a 15-pin sub-D connector at the DTE end.

To connect two active network components, an Industrial Twisted Pair cable with two 9-pin sub-D connectors is used. The two wire pairs are crossed over. Crossed wires have the additional “XP” marking (crossed pairs).

To connect two DTEs to each other, an Industrial Twisted Pair cable with two 15-pin sub-D connectors is used. The wire pairs are again crossed over and this cable also has the additional “XP” marking.

Product Range

The following preassembled Industrial Twisted Pair cables are available:

Table 4-10 Industrial Twisted Pair Cable Products

Cable Name	Use	Suppliable Lengths	Order number
ITP standard cable 9/15	ITP installation cable is used for direct attachment of DTEs with an ITP port to Industrial Ethernet network components with an ITP port; with one 9-pin and one 15-pin sub-D connector	2 m, 5 m, 8 m, 12 m, 15 m, 20 m, 30 m, 40 m, 50 m, 60 m, 70 m, 80 m, 90 m, 100 m	6XV1850-0Bxxx 1)
ITP XP standard cable 9/9	Crossover ITP installation cable for direct connection of two Industrial Ethernet network components with an ITP port; with two 9-pin sub-D connectors	2 m, 5 m, 8 m, 12 m, 15 m, 20 m, 30 m, 40 m, 50 m, 60 m, 70 m, 80 m, 90 m, 100 m	6XV1850-0Cxxx 1)
ITP XP standard cable 15/15	Crossover ITP installation cable for direct connection to DTEs with an ITP port; with two 15-pin sub-D connectors	2 m, 6 m, 10 m	6XV1850-0Dxxx 1)

1) For a complete list of the order numbers, refer to the catalog IK PI

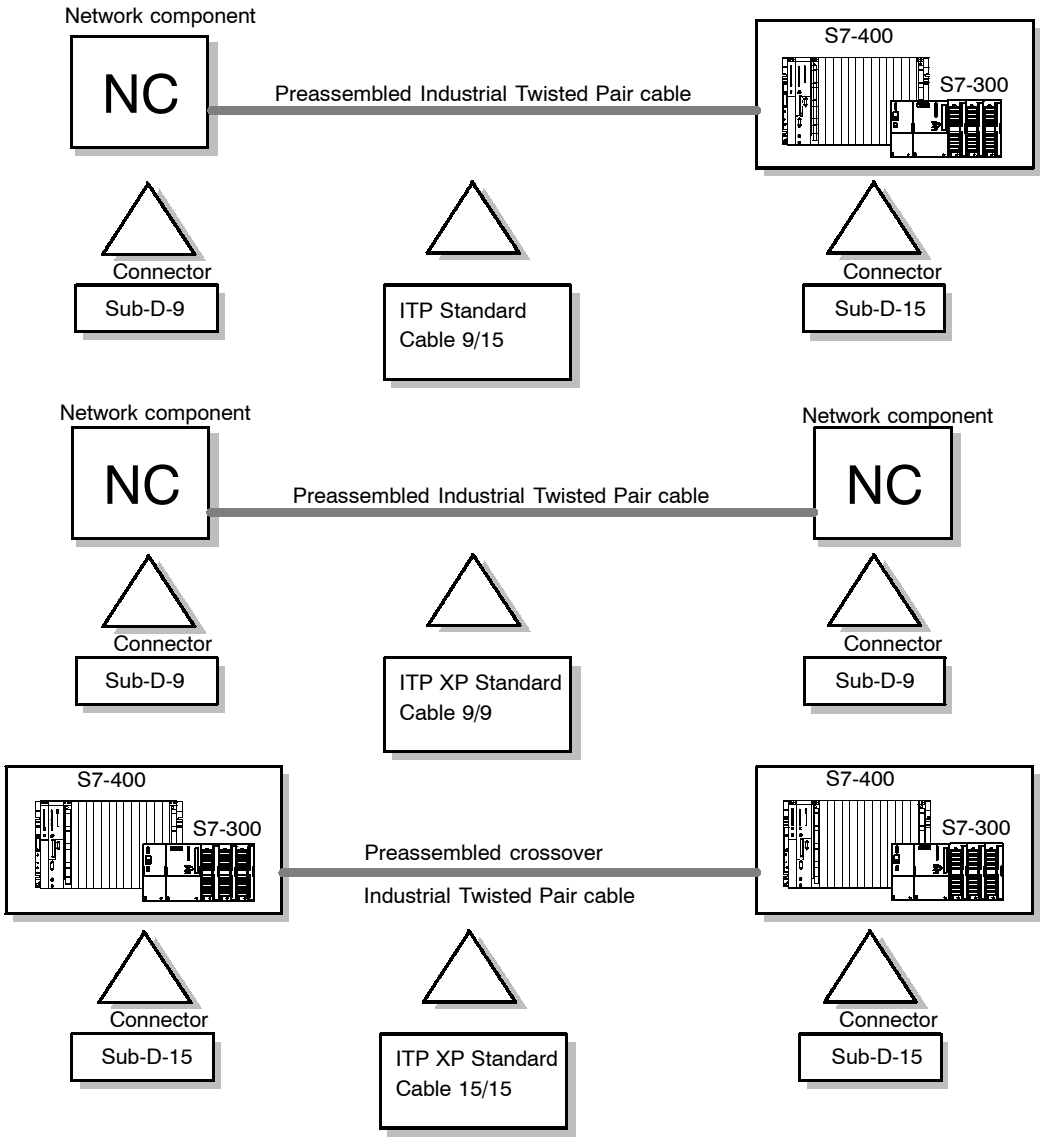
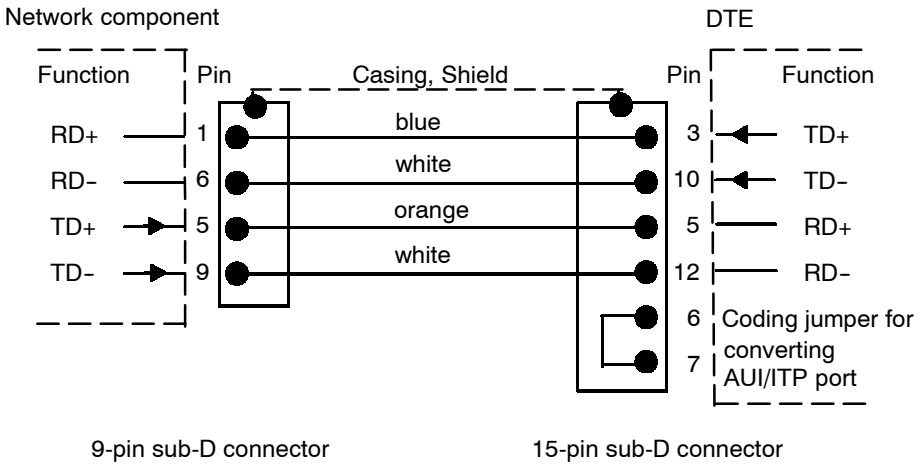
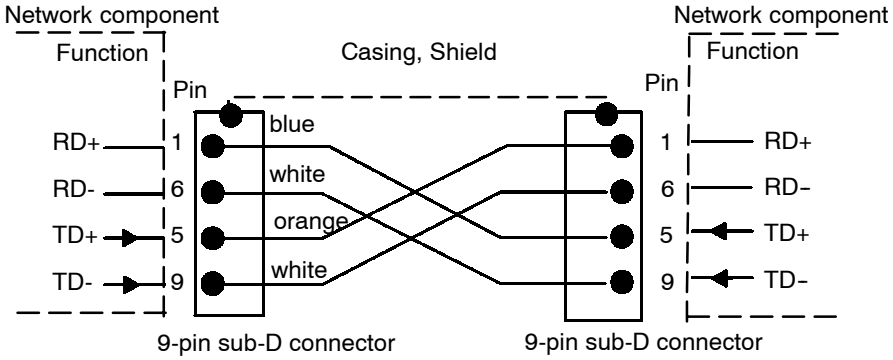


Figure 4-5 Use of Preassembled Industrial Twisted-Pair Cables for Direct Links Between Components

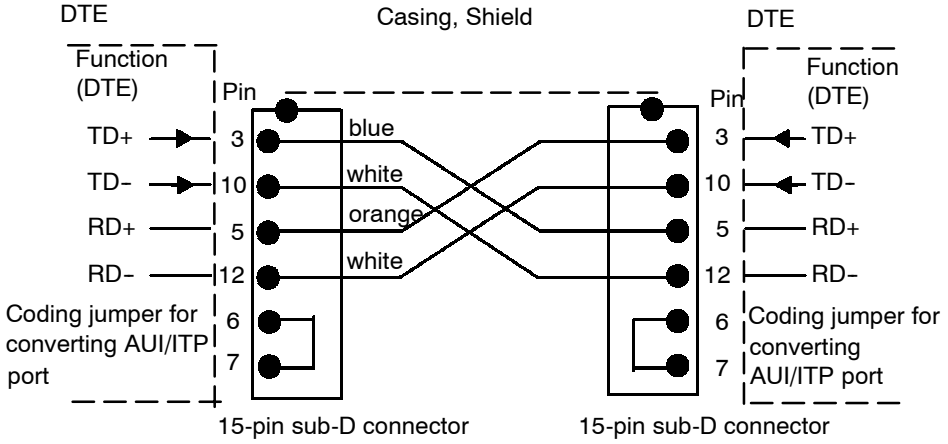
Pinning



a) Pinning of the ITP standard cable 9/15



b) Pinning of the ITP XP standard cable 9/9



c) Pinning of the ITP XP standard cable 15/15

Figure 4-6 Pinning of the Industrial Twisted Pair Standard Cables

4.5.2 Preassembled Twisted-Pair Cords

General

In environments in which low noise levels can be expected and for lines up to 10 m, twisted-pair cables can be used. These use the TP cord that is much thinner and more flexible than the Industrial Twisted Pair cables due to the reduced shielding. Both the standard RJ-45 connectors and sub-D connectors are used to connect Industrial Twisted Pair components.

Product Range

The following preassembled twisted-pair cables are available:

Table 4-11 Twisted-Pair Cable Products

Cable Name	Use	Suppliable Lengths	Order number
TP Cord RJ-45/RJ-45	TP patch cable with 2 RJ-45 plugs	0.5 m 1.0 m 2.0 m 6.0 m 10.0 m	6XV1 850-2GE50 6XV1 850-2GH10 6XV1 850-2GH20 6XV1 850-2GH60 6XV1 850-2GN10
TP XP Cord RJ-45/RJ-45	Crossover TP cable with 2 RJ-45 plugs	0.5 m 1.0 m 2.0 m 6.0 m 10.0 m	6XV1 850-2HE50 6XV1 850-2HH10 6XV1 850-2HH20 6XV1 850-2HH60 6XV1 850-2HN10
TP cord 9/RJ-45	TP cable with one 9-pin sub-D connector and one RJ-45 plug	0.5 m 1.0 m 2.0 m 6.0 m 10.0 m	6XV1 850-2JE50 6XV1 850-2JH10 6XV1 850-2JH20 6XV1 850-2JH60 6XV1 850-2 JN10
TP XP Cord 9/RJ-45	Crossover TP cable with one 9-pin sub-D connector and one RJ-45 plug	0.5 m 1.0 m 2.0 m 6.0 m 10.0 m	6XV1 850-2ME50 6XV1 850-2MH10 6XV1 850-2MH20 6XV1 850-2MH60 6XV1 850-2MN10
TP Cord 9-45/RJ-45	TP cable with one RJ-45 plug and one sub-D connector with 45° cable outlet (only for OSM/ESM)	1.0 m	6XV1 850-2NH10
TP XP Cord 9-45/RJ-45	Crossover TP cable with one RJ-45 plug and one sub-D connector with 45° cable outlet (only for OSM/ESM)	1.0 m	6XV1 850-2PH10
TP XP cord 9/9	Crossover TP cable for direct linking of two Industrial Ethernet network components with ITP port with two 9-pin sub-D connectors	1.0 m	6XV1850-2RH10

Table 4-11 Twisted-Pair Cable Products

Cable Name	Use	Suppliable Lengths	Order number
TP Cord RJ-45/15	TP cable with one 15-pin sub-D connector and one RJ-45 plug	0.5 m 1.0 m 2.0 m 6.0 m 10.0 m	6XV1 850-2LE50 6XV1 850-2LH10 6XV1 850-2LH20 6XV1 850-2LH60 6XV1 850-2LN10
TP XP Cord RJ-45/15	Crossover TP cable with one 15-pin sub-D connector and one RJ-45 plug	0.5 m 1.0 m 2.0 m 6.0 m 10.0 m	6XV1 850-2SE50 6XV1 850-2SH10 6XV1 850-2SH20 6XV1 850-2SH60 6XV1 850-2SN10

For a complete list of the order numbers, refer to the catalog IK PI

Areas of Application

The following tables show the available cables and their applications.

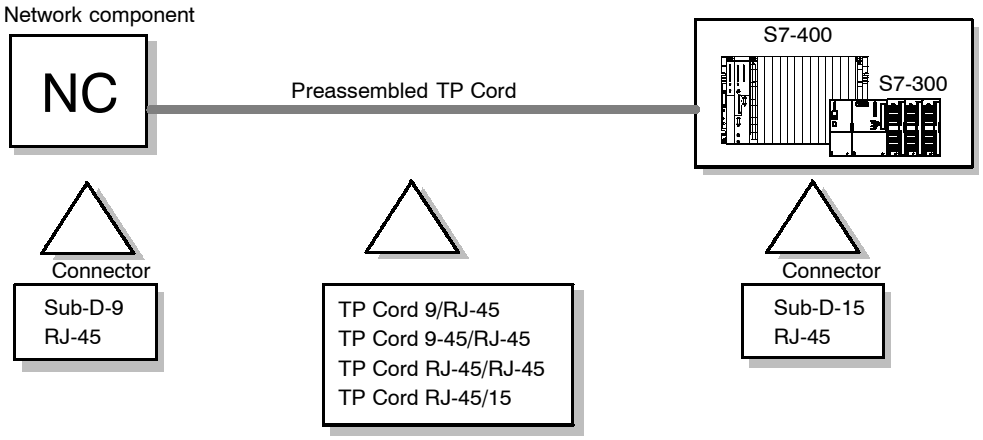


Figure 4-7 Direct Link between a DTE and a Network Component

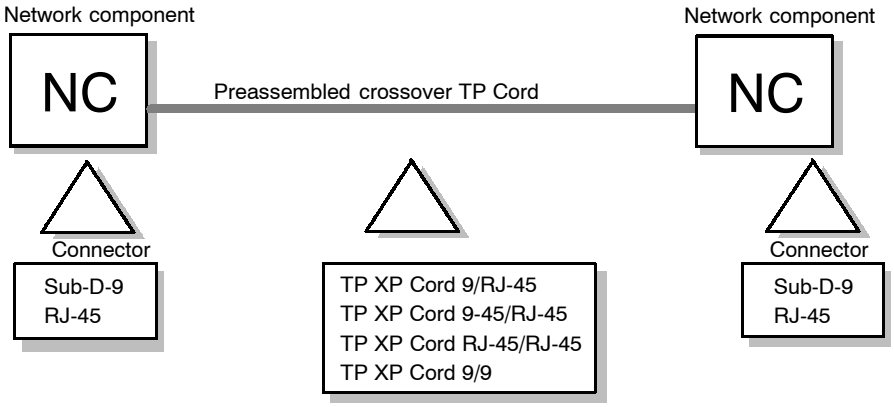


Figure 4-8 Direct Link between Two Network Components

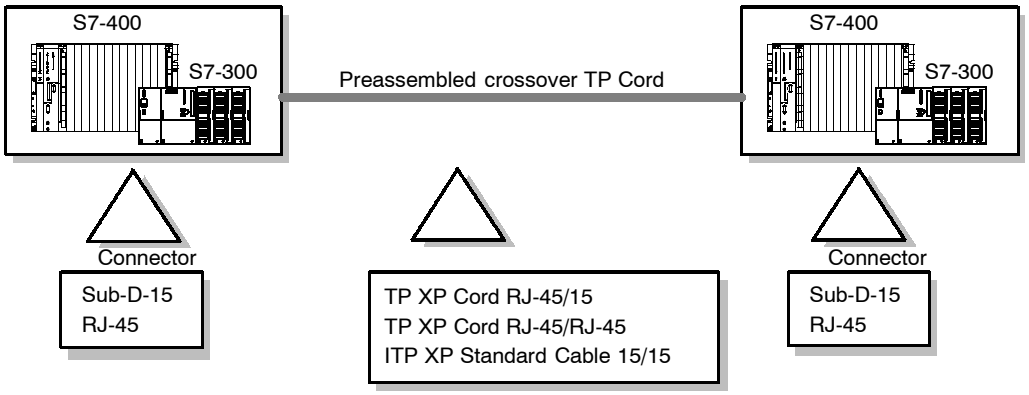


Figure 4-9 Direct Link between Two DTEs

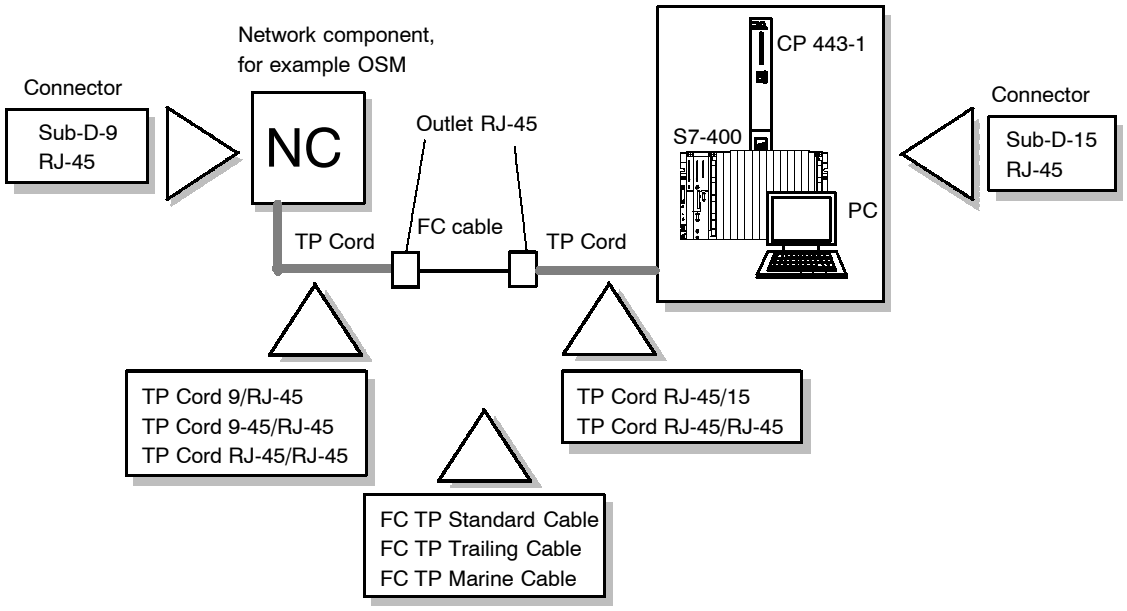


Figure 4-10 Structured Cabling between a DTE and a Network Component

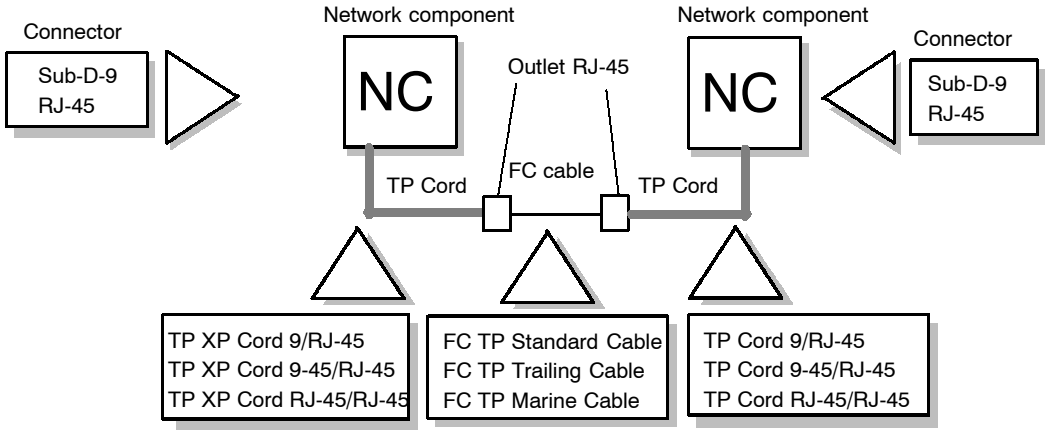


Figure 4-11 Structured Cabling between Two Network Components

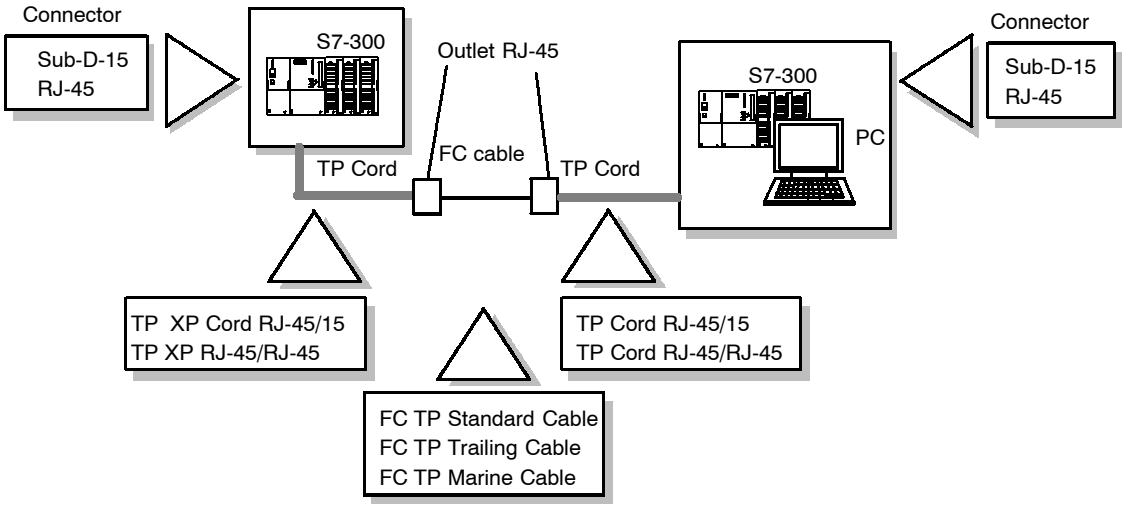
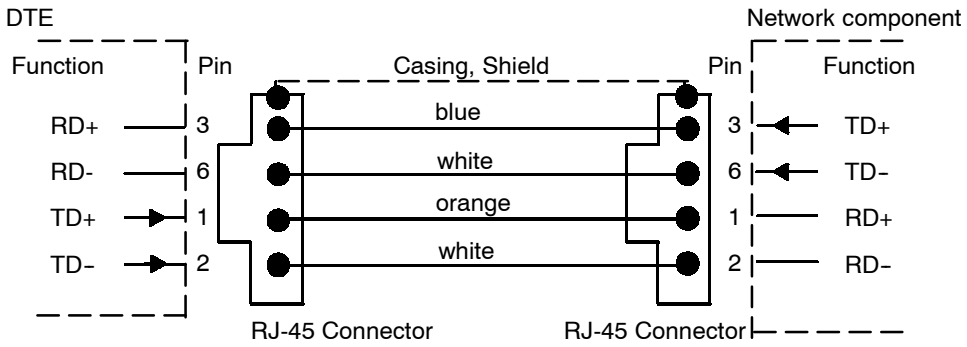
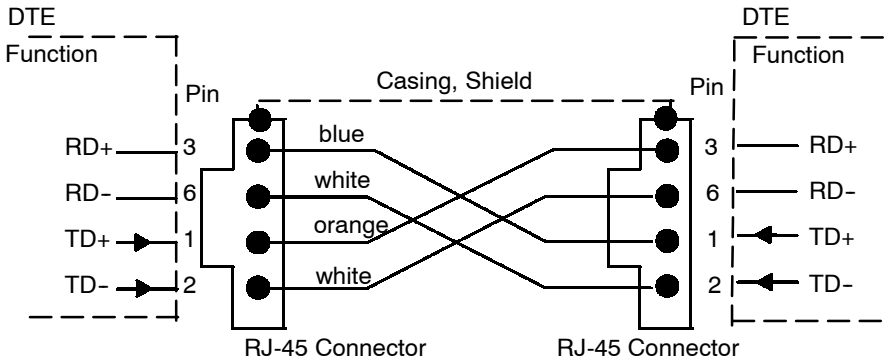


Figure 4-12 Structured Cabling between Two DTEs

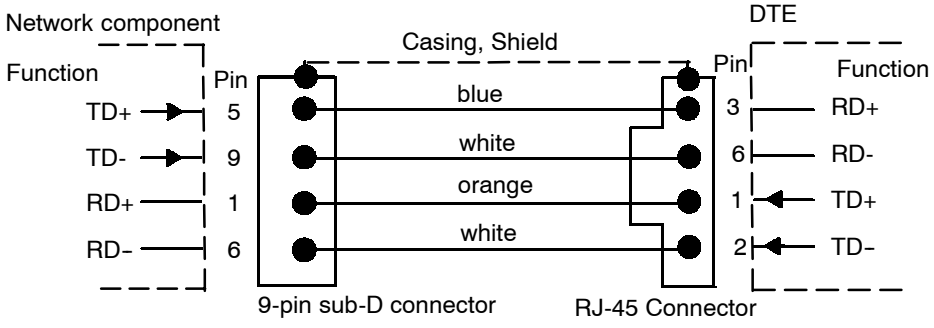
Pinning



a) Pinning of the TP Cord RJ-45/RJ-45

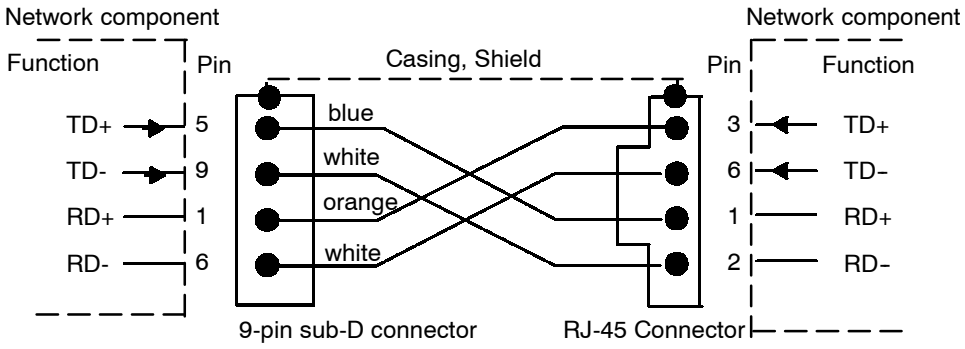


b) Pinning of the TP XP Cord RJ-45/RJ-45

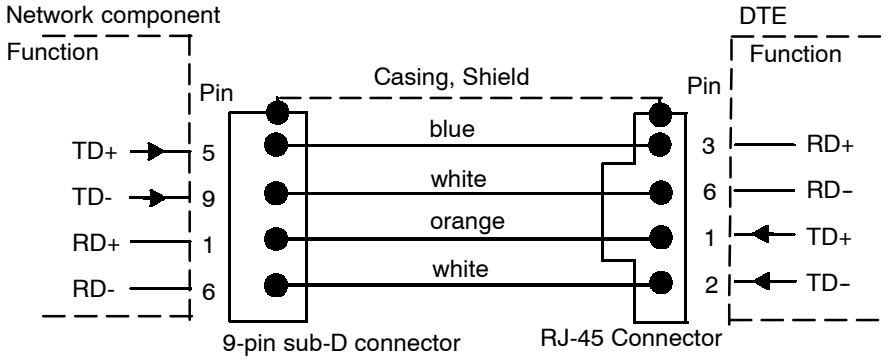


c) Pinning of the TP Cord 9/RJ-45

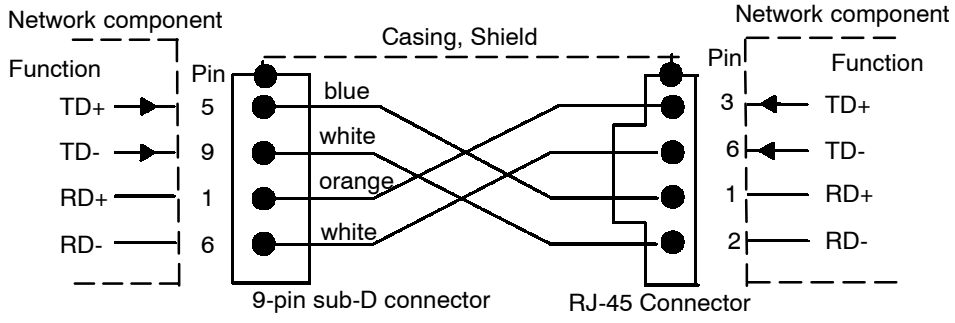
Figure 4-13 Pinning of TP Cords



d) Pinning of the TP XP Cord 9/RJ-45

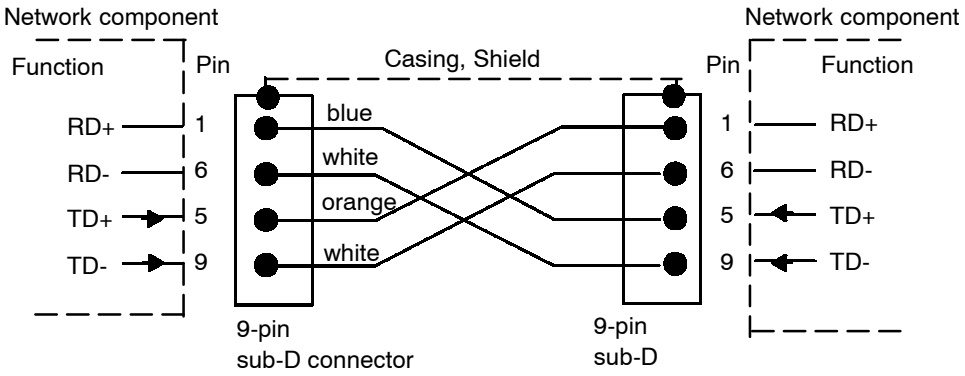


e) Pinning of the TP Cord 9-45/RJ-45

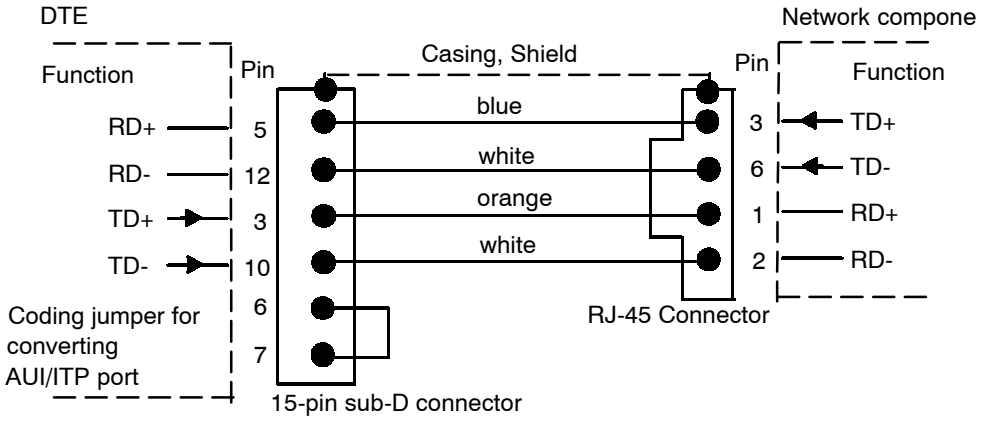


f) Pinning of the TP XP Cord 9-45/RJ-45

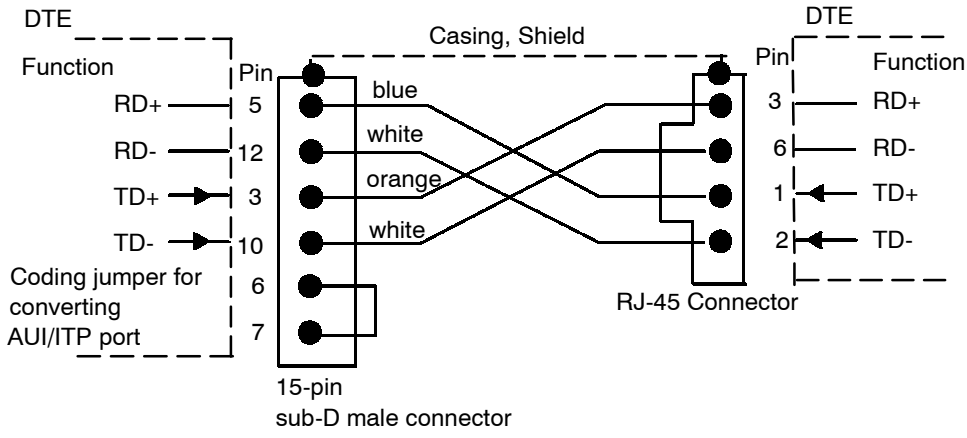
Figure 4-14 Pinning of TP Cords



g) Pinning of the TP XP Cord 9/9



h) Pinning of the TP Cord 15/RJ-45



i) Pinning of the TP XP Cord 15/RJ-45

Figure 4-15 Pinning of TP Cords

4.5.3 Twisted-Pair Port Converter

General

Port converters are used to connect a DTE with an RJ-45 port to the Industrial Twisted Pair cabling system.

The port converter has an RJ-45 connector at one end to connect to the DTE and a 15-pin sub-D female connector with a slide locking mechanism at the other end. The male and female connector are connected by a short TP cord. This converts the RJ-45 port of the DTE to an Industrial Twisted Pair DTE port. Up to 90 m long, double shielded ITP standard cables can be connected to the 15-pin sub-D female connector and can be installed in areas with high EMI.

Mounting Bracket

The sub-D female connector has a mounting bracket. This allows the socket to be fixed in place. The mounting bracket has two functions:

- Strain relief
  The TP cord and the RJ-45 port on the DTE are protected from tensile strain.
- Grounding
  The mounting bracket is electrically connected with the casing of the female connector and therefore also with the cable shields. The bracket should be screwed to a grounded plate or rail ensuring good contact.

Product Range

Table 4-12 TP Converter Cord 15/RJ-45 Data

Cable Name	Use	Suppliable Lengths	Order number
TP converter cord 15/RJ-45	TP patch cable for attachment of DTEs with an RJ-45 port to the ITP cabling system; with one 15-pin sub-D female connector with slide locking mechanism and one RJ-45 plug	0.5 m 2 m	6XV1850-2EE50 6XV1850-2EH20

Pinning

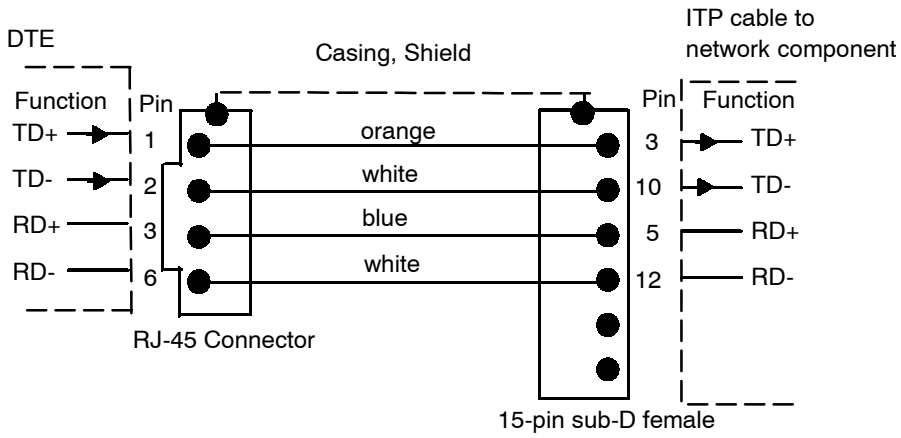


Figure 4-16 Pinning of the TP Converter Cord 15/RJ-45

4.6 Industrial Twisted Pair Sub-D Connectors

General

The Industrial Twisted Pair sub-D connectors correspond to the standards MIL-C-24308 and DIN 41652. Due to its mechanical strength and its excellent electromagnetic compatibility, this connector was preferred to the RJ-45 connector recommended for 10BASE-T in IEEE 802.3.

Two versions of the connector are available:

- Preassembled (crimped)
- For assembly by the user

Design of the Connectors for User Assembly

The following sections describe only the connectors that can be assembled by the user.

There are two versions of the Industrial Twisted Pair sub-D connectors for user assembly:

- 9-pin connector with straight cable outlet and securing screws
- 15-pin connector with variable cable outlet (+30° , 0°, -30°) and securing bolts

Both connector types have a metal casing. The Industrial Twisted Pair cables are connected to the connector pins using screw terminals, special tools are not required.

For a detailed description of fitting connectors, refer to Section 7.9.

Industrial Twisted Pair Sub-D Connector 9-pin

- Intended for connecting:
  - OLM/ELM (ports 1-3)
  - OSM/ESM (ports 1-6, standby-sync port)
  - Interface card ECTP3 (ports 1-3) for star coupler (ASGE)
- Connector casing with straight cable outlet
- Can be mechanically secured to the female connector with integrated knurled screws
- Simple cable assembly with screw terminals

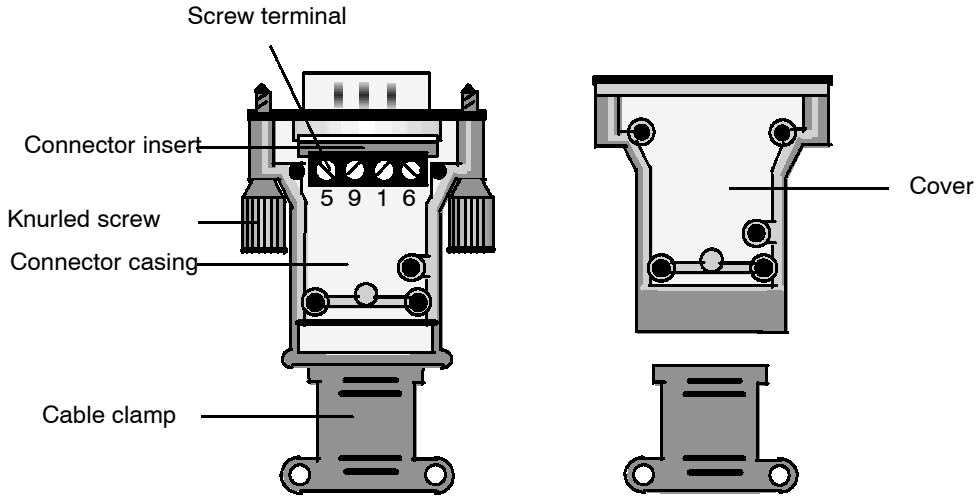


Figure 4-17 Industrial Twisted Pair Sub-D connector (9-pin) for Assembly on Site

Industrial Twisted Pair Sub-D Connector 15-pin

- For connection to DTEs with an integrated Industrial Twisted Pair port
- Cable casing with variable cable insertion angle

  +30° , 0° , -30°
- Slide mechanism for locking to female connector
- Two dummy plugs for closing unused cable outlets
- Simple cable assembly with screw terminals
- Internal coding jumper for converting the DTE port from AUI to Industrial Twisted Pair

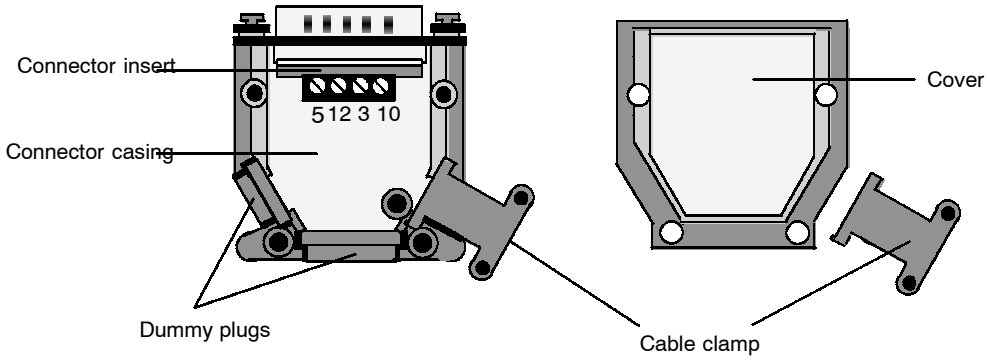


Figure 4-18 Industrial Twisted Pair Sub-D Connector (15-pin) for Assembly on Site

4.7 RJ-45 Connector

The RJ-45 plug is an 8-pin plug designed in compliance with ISO/IEC 8877:1992. This type of connector is recommended in IEEE 802.3 for 10BASE-T and 100BASE–TX. The RJ-45 connector is used mainly in an environment with low EMI levels (for example in offices). This connector was developed by Western Electric and is also known as the Western plug.

The RJ-45 connector cannot be ordered separately and is supplied only with preassembled cables (TP cord).

- Connector casing with straight cable outlet
- Intended for connecting:
  - DTEs with an RJ-45 port and
  - network components with an RJ-45 port

RJ-45 Connector System

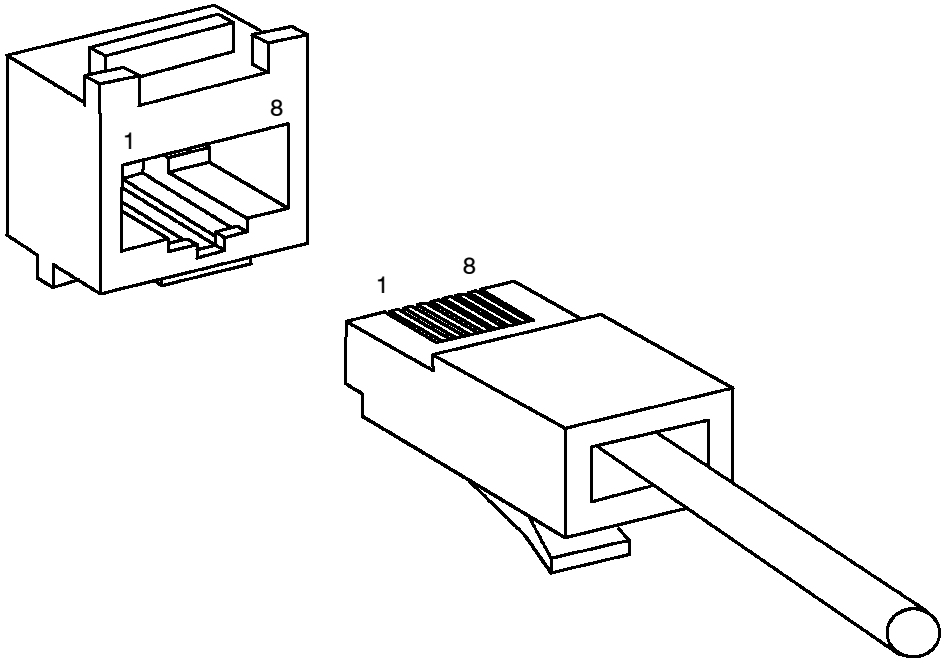


Figure 4-19 RJ-45 Jack and Plug

4.8 Industrial Ethernet FC Outlet RJ-45

General

The Industrial Ethernet FC Outlet RJ-45 is used to implement the transition of the robust Industrial Ethernet FC TP cables used in the industrial environment to preassembled TP Cord cables using an RJ-45 jack. When used with FC TP cables and preassembled TP Cords, the Industrial Ethernet FC Outlet RJ-45 saves considerable time during installation.
Color coding prevents errors when connecting the wires. The Industrial Ethernet FC Outlet RJ-45 corresponds to category 5 of the international cabling standards ISO/IEC 11801 and EN 50173.

Design

The Industrial Ethernet FC Outlet RJ-45 consists of a robust metal casing. The screw on cover ensures reliable shield contact and strain relief for the Industrial Ethernet FC cable.

The outlet RJ-45 has the following terminals:

- 4 insulation-piercing contacts for connecting the Industrial Ethernet FC cable (contacts color-coded)
- RJ-45 jack with dust protection cap for connecting various TP Cord cables.

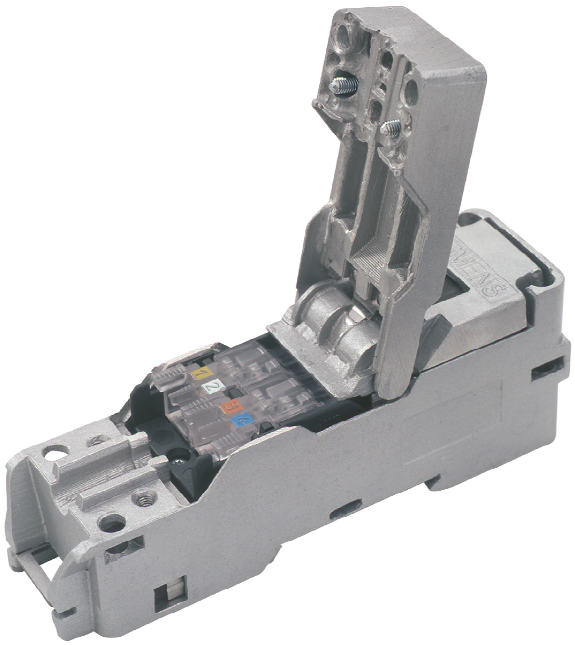


Figure 4-20 Industrial Ethernet FC Outlet RJ-45

Installation

The FC Outlet RJ-45 is suitable both for installation on a standard rail and for wall installation. The outlet has four holes to allow wall installation.

By arranging several FC Outlet RJ-45 devices in a line, you can create a patch panel with any terminal density you require (for example 16 outlets to a width of 19" is possible with a suitably wide rail). The FC Outlet RJ-45 can also be installed behind a metal panel with a suitable cutout (for example in a wiring closet).

Example of an Application

The Industrial Ethernet FC Outlet RJ-45 is attached directly to the Industrial Ethernet FC TP cable. To connect the FC Outlet RJ-45 and network components or a DTE, various preassembled RJ-45 patch cables are available.

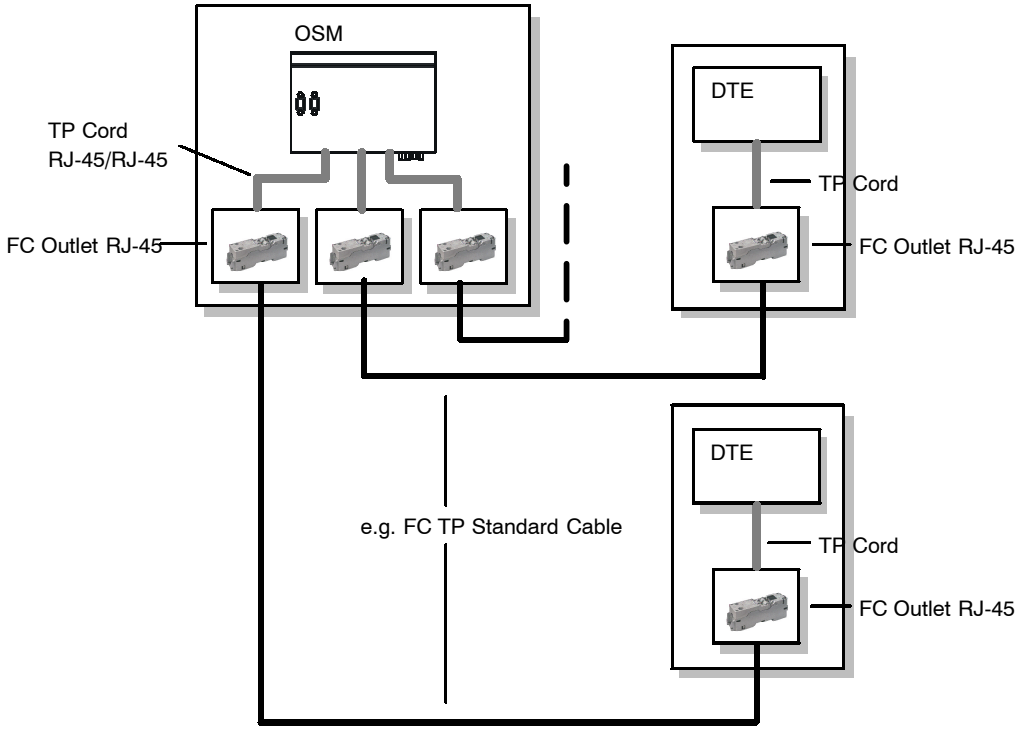


Figure 4-21 System Configuration with FC Outlet RJ-45

Pinning of the FC Outlet RJ-45

The contacts of the RJ-45 jack and the insulation-piercing terminals for the FC TP cable are assigned to each other as follows:

RJ-45 pin number	Insulation piercing terminals	
	Number	Wire color
1	1	yellow
2	3	orange
3	2	white
6	4	blue

Technical Specifications

Table 4-13 FC Outlet RJ-45 Technical Specifications

Ports • Attachment of DTEs, network components • Attachment of Industrial Ethernet FC TP cables	 RJ-45 jack 4 insulation-piercing terminals
Installation	Standard rail or wall installation
Permitted environmental conditions • Operating temperature • Storage/transport temperature	 –25 °C to +70 °C –40 °C to +70 °C
Construction • Dimensions (W x H x D) in mm • Weight	 107x31.7x30 300 g
Degree of protection	IP20
Transmission characteristics	Corresponding to category 5 of the international cabling standards ISO/IEC 11801 and EN 50173

Ordering Data:

Table 4-14 Ordering Data of the FC Outlet RJ-45

Industrial Ethernet FC Outlet RJ-45 For connecting Industrial Ethernet FC TP cables and TP Cords	**6GK1 901-1FC00 0AA0**

Passive Components for Optical Networks 5

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5.1 Optical Transmission Technique

Fiber-Optic Cables (FO)

On fiber-optic cables (FO) data is transmitted by modulating electromagnetic waves in the range of visible and invisible light. The material used is high-quality glass fiber.

This section describes only the SIMATIC NET fiber-optic cables intended for Industrial Ethernet. The various FO types allow flexible solutions with which components can be interconnected depending on the operating and environmental conditions.

Compared with electrical cables, fiber-optic cables have the following advantages:

Advantages

- Electrical isolation of nodes and segments
- No grounding problems
- No shield currents
- Transmission path immune to external electromagnetic noise
- No lightning protection required
- No noise emission along the transmission path
- Light weight
- Depending on the fiber type, cables several kilometers long can be used even at higher transmission rates.

Point-to-Point Link

Fiber-optic technology only allows the implementation of point-to-point links; in other words, one transmitter is connected to only one receiver. The transmission path between two nodes requires two fibers (one for each transmission direction). All SIMATIC NET standard fiber-optic cables are therefore designed as duplex cables.

5.2 Glass Fiber-Optic Cables

Designed for Industry

SIMATIC NET glass fiber-optic cables (FO) are available in various designs allowing optimum adaptation to a wide range of applications.

Areas of Application

Fiber-optic standard cable

- Universal cable for use indoors and outdoors

INDOOR fiber-optic cable

- Free of halogens, can be walked on, and extremely flame-retardant FO cable for use in buildings

Flexible fiber-optic trailing cable

- Specially designed for non-stationary use, for example with moving machinery

SIENOPYR duplex marine fiber-optic cable

- Hybrid cable consisting of two fibers and two additional copper wires for fixed installation on ships and offshore facilities

SIMATIC NET Standard Fibers

In glass fiber-optic cables, SIMATIC NET uses a fiber with 62.5 µm diameter as its standard fiber. SIMATIC NET bus components are ideally matched to these standard fibers allowing large distances to be covered while keeping the configuration rules simple.

Simple Configuration

All the descriptions and operating instructions for SIMATIC NET bus components contain information about the distances that can be covered with the standard fibers described above. You can configure your optical network without complicated calculations using simple limit values (refer to Chapter 3 “Network Configuration”).

Guidelines for Laying Cables

You will find information about laying SIMATIC NET glass fiber-optic cables in Section 7.7 in this manual.

Technical Specifications

Tables 5-1 and 5-2 provide an overview of the technical specifications of all SIMATIC NET glass fiber-optic cables.

Table 5-1 Technical Specifications of the INDOOR Fiber-Optic Cable and Fiber-Optic Standard Cable

Cable Type	Fiber-Optic Standard Cable	INDOOR Fiber-Optic Cable
Areas of application	Universal cable for use indoors and outdoors	Halogen-free and extremely flame-retardant cable for indoor use that can be walked on
Available as	Preassembled cable with 4 BFOC connectors in fixed lengths, also available in meters	Preassembled cable with 4 BFOC connectors in fixed lengths
Cable type (standard designation)	AT-VYY 2G62.5/125 3.1B200+0.8F600 F	I-VHH 2G62.5/125 3.2B200+0.9F600 F TB3 FRNC OR
Fiber type	Multimode graded fiber 62.5/125 µm	Multimode graded fiber 62.5/125 µm
Power loss at 850 nm Power loss at 1300 nm	<= 3.1 dB/km <= 0.8 dB/km	<= 3.2 dB/km <= 0.9 dB/km
Modal bandwidth at 850 nm at 1300 nm	 200 MHz *km 600 MHz *km	 200 MHz *km 600 MHz *km
Number of fibers	2	2
Cable Structures	Splittable outdoor cable	Splittable indoor cable
Core type	Compact core	Fixed core
Basic element materials	PVC, gray	Copolymer, orange (FRNC)
Strain relief	Aramid yarn and impregnated glass fiber yarn	Aramid yarn
Outer sheath/ color of cable	PVC/black	Copolymer/ bright orange (FRNC)
Dimensions of basic element	(3.5 ± 0.2) mm ∅	2.9 mm ∅
Outer dimensions	(6.3 x 9.8) ± 0.4 mm	approx. 3.9 x 6.8 mm
Cable weight	approx. 74 kg/km	approx. 30 kg/km
Permitted tensile stress	<= 370 N (in operation) <= 500 N (brief)	<=200 N (in operation) <= 800 N (brief)
Bend Radius	100 mm Only the flat surface	100 mm (during installation) 60 mm (in operation) Only the flat surface
Transverse compressive strength	5,000 N/10 cm	3,000 N/10 cm (brief) 1,000 N/10 cm (permanent)

Table 5-1 Technical Specifications of the INDOOR Fiber-Optic Cable and Fiber-Optic Standard Cable

Cable Type	Fiber-Optic Standard Cable	INDOOR Fiber-Optic Cable
Impact strength	3 blows (initial energy: 5 Nm hammer radius: 300 mm)	3 blows (initial energy: 1.5 Nm hammer radius: 300 mm)
Installation temperature	-5°C to +50°C	-5°C to +50°C
Operating temperature	-25°C to +60°C	-20°C to +60°C
Storage temperature	-25°C to +70°C	-25°C to +70°C
Behavior in fire	Flame-retardant complying with IEC 60332-3 cat. CF	Flame-retardant complying with IEC 60332-3 and DIN VDE 0472 Part 804, test type B
Free of halogens	no	yes
UL approval	no	no
Ship building approval	no	no

Table 5-2 Technical Specifications of the Flexible Fiber-Optic Trailing Cable and the SIENOPYR Duplex Fiber-Optic Marine Cable

Cable Type	Flexible Fiber-Optic Trailing Cable	SIENOPYR Duplex Fiber-Optic Marine Cable
Areas of application	Flexible cable for installation in a drag chain indoors and outdoors	Fixed installation on ships and offshore facilities in all enclosed spaces and on free decks
Available as	Preassembled cable with 4 BFOC connectors in fixed lengths, also available in meters	Sold in meters
Cable type (standard code)	AT-W11Y (ZN) 11Y2G62.5/125 3,1B200+0.8F600 LG	MI-VHH 2G 62.5/125 3,1B200 + 0.8F600 + 2x1CU 300 V
Fiber type	Multimode graded fiber 62.5/125 µm	Multimode graded fiber 62.5/125 µm
Power loss at 850 nm Power loss at 1300 nm	<= 3.1 dB/km <= 0.8 dB/km	<= 3.1 dB/km <= 0.8 dB/km
Modal bandwidth at 850 nm at 1300 nm	200 MHz *km 600 MHz *km	200 MHz *km 600 MHz *km
Number of fibers	2	2
Cable Structures	Splittable outdoor cable	Splittable outdoor cable
Core type	Hollow core, filled	Solid core
Basic element materials	PUR, black	Polyolefin

Table 5-2 Technical Specifications of the Flexible Fiber-Optic Trailing Cable and the SIENOPYR Duplex Fiber-Optic Marine Cable

Cable Type	**Flexible Fiber-Optic Trailing Cable**	**SIENOPYR Duplex Fiber-Optic Marine Cable**
Strain relief	GFK central element, Aramid yarn	Aramid yarn
Outer sheath/color of cable	PUR, black	SHF1 mixture/black
Dimensions of basic element	(3. ± 0.2) mm ∅	(2.9 ± 0.2) mm ∅
Outer dimensions	approx. 12.9 mm	(13.3 ± 0.5) mm
Cable weight	approx. 136 kg/km	approx. 220 kg/km
Permitted tensile stress	<= 2000 N (brief) <=1000 N (permanent)	<= 500 N (brief) <= 250 N (permanent)
Bend Radius	150 mm Max. 100,000 bending cycles	133 mm (single) 266 mm (multiple)
Installation temperature	-5°C to +50°C	-10°C to +50°C
Operating temperature	-25°C to +60°C	-40°C to +80°C 1) -40°C to +70°C 2)
Storage temperature	-25°C to +70°C	-40°C to +80°C
Resistance to fire	Complying with IEC 60332-1	Complying with IEC 60332-3 cat. A
Free of halogens	no	yes
UL approval	no	no
Ship building approval	no	yes

1) With no load on copper cores
2) With maximum load on copper cores (6 A)

5.2.1 Fiber-Optic Standard Cable

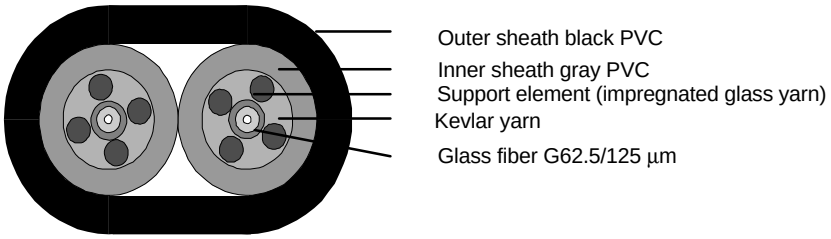

Figure 5-1 Structure of the Fiber-Optic Standard Cable

Fiber-Optic Standard Cable 6XV1820-5****

The fiber-optic standard cable contains two multimode graded fibers of type 62.5/125 µm.

The outer sheath is labeled “SIEMENS SIMATIC NET FIBER-OPTIC 6XV1 820-5AH10” approximately every 50 cm. Meter markers consisting of a vertical line and a 4-figure number make it easier to estimate the length of an installed cable.

Properties

The fiber-optic standard cable has the following properties:

- Can be walked on
- Flame-retardant complying with IEC 60332-3 cat. CF
- Not halogen free
- Available in meter lengths up to 4000 m
- Available preassembled with 4 BFOC connectors in lengths up to 1000 m

Application

The fiber-optic standard cable is the universal cable for use indoors and outdoors. It is suitable for connecting optical ports operating at the wavelengths of 850 nm and 1300 nm.

5.2.2 INDOOR Fiber-Optic Cable

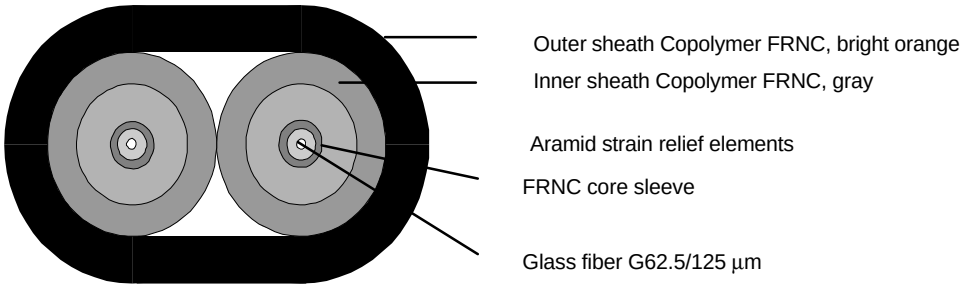
Outer sheath Copolymer FRNC, bright orange
Inner sheath Copolymer FRNC, gray
Aramid strain relief elements
FRNC core sleeve
Glass fiber G62.5/125 µm

Figure 5-2 Structure of the INDOOR Fiber-Optic Cable

INDOOR Fiber-Optic cable 6XV1820-7****

The INDOOR fiber-optic cable contains two multimode graded fibers 62.5/125 µm.

The outer sheath is labeled “SIEMENS SIMATIC NET INDOOR FIBER OPTIC 6XV1 820-7AH10 FRNC” at intervals of approximately 50 cm. Meter markers consisting of a vertical line and a 4-figure number make it easier to estimate the length of an installed cable.

Properties

The INDOOR fiber-optic cable has the following properties:

- Can be walked on
- Flame-retardant complying with IEC 60332-3 and DIN VDE 0472 Part 804, test type B
- Is free of halogens
- Preassembled with 4 BFOC connectors in lengths from 0.5 m to 100 m.

Application

The INDOOR fiber-optic cable is intended for use indoors in areas protected from the weather. It is suitable for connecting optical ports operating at the wavelengths of 850 nm and 1300 nm.

5.2.3 Flexible Fiber-Optic Trailing Cable

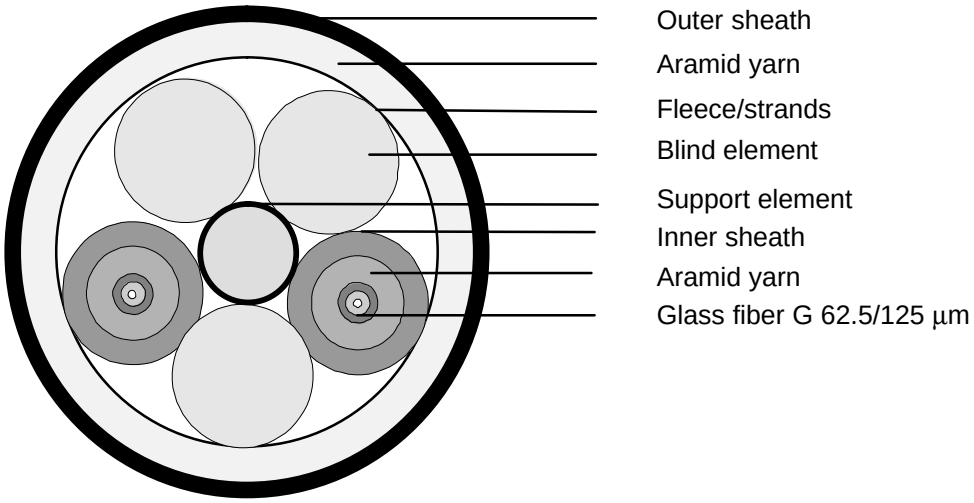

Figure 5-3 Structure of the Flexible Fiber-Optic Trailing Cable

Flexible Fiber-Optic Trailing Cable 6XV1820-6****

The flexible fiber-optic trailing cable contains two multimode graded fibers 62.5/125 µm. Integrated blind elements produce a round cross-section.

The outer sheath is labeled “SIEMENS SIMATIC NET FLEXIBLE FIBER OPTIC 6XV1 820-6AH10” at intervals of approximately 50 cm. Meter markers consisting of a vertical line and a 4-figure number make it easier to estimate the length of an installed cable.

Properties

The flexible fiber-optic trailing cable has the following properties:

- Highly flexible (100,000 bending cycles at a minimum bend radius of 150 mm)
- Not halogen free
- Available in meter lengths for up to 2000 m
- Available preassembled with 4 BFOC connectors in fixed lengths up to 650 m

Application

The flexible fiber-optic trailing cable was developed for applications in which the cable must be flexible enough to move, for example when attached to moving machine parts (drag chains). The cable is designed for 100,000 bending cycles through ± 90° (at the specified minimum bend radius). The trailing cable can be used both indoors and outdoors. It is suitable for connecting optical ports operating at the wavelengths of 850 nm and 1300 nm.

Warning

During installation and operation, all the mechanical restrictions such as bend radii, tensile strain etc. must be adhered to. If these limits are exceeded, permanent deterioration of the transmission characteristics may result that can cause temporary or permanent failure of data transmission.

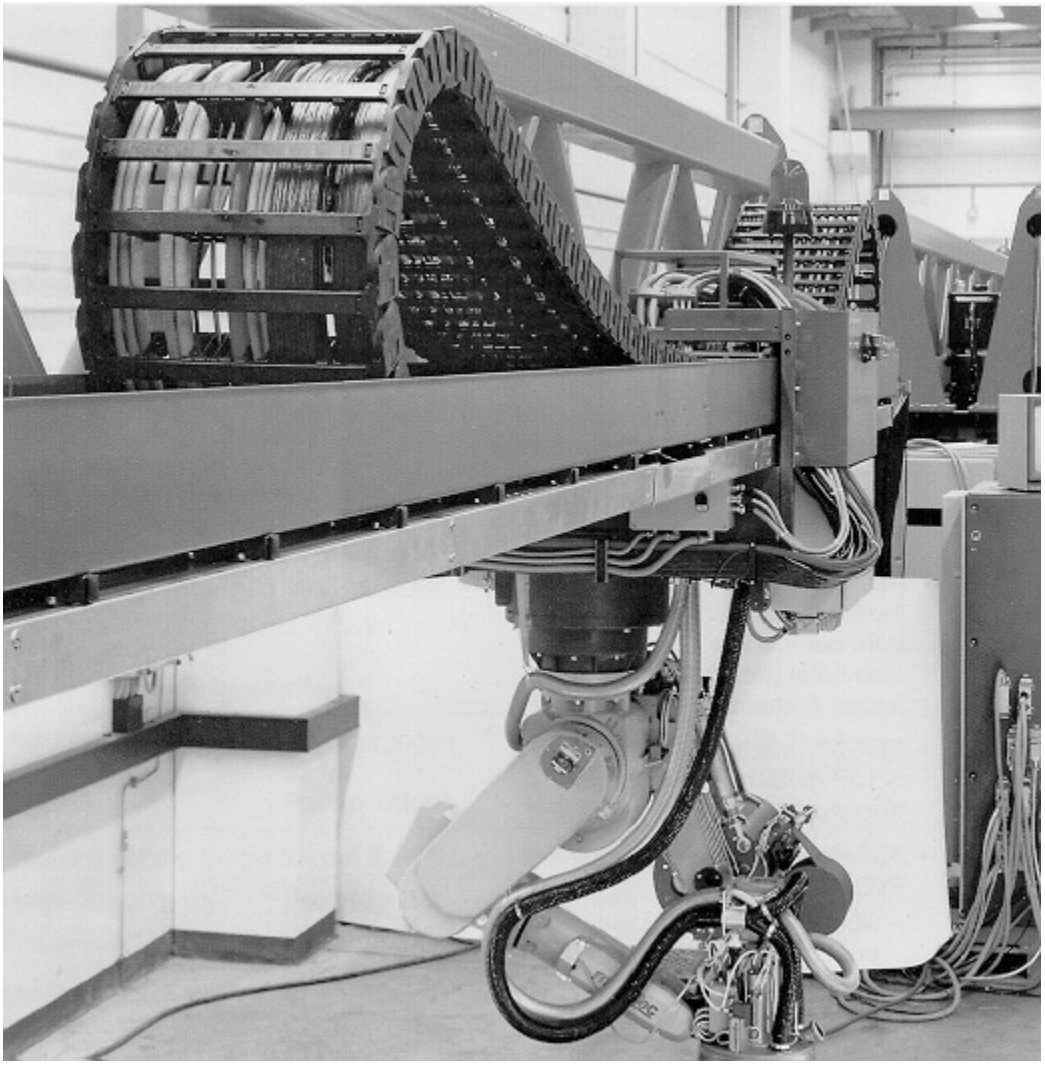

Figure 5-4 Example of Using the Glass Fiber-Optic Trailing Cable in a Drag Chain

5.2.4 SIENOPYR Duplex Fiber-Optic Marine Cable

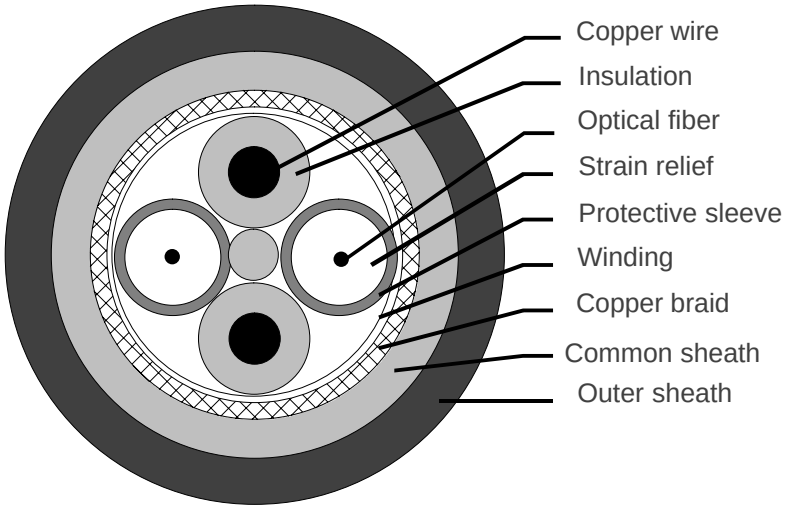

Figure 5-5 Structure of the SIENOPYR Duplex Fiber-Optic Marine Cable

SIENOPYR Duplex Fiber-Optic Marine Cable 6XV1 830-0NH10

The SIENOPYR duplex fiber-optic marine cable contains two multimode graded fibers 62.5/125 µm. The cable also contains two stranded, rubber-insulated copper wires with a 1 mm^2 cross-sectional area. These can be used, for example, to supply power to the attached devices.

The round cross-section of the cable makes it easier to seal cable glands.

The outer sheath is labeled with the year of manufacture and the label "SIENOPYR-FR MI-VHH 2G 62.5/125 3,1B200+0,8F600+2x1CU 300V" at intervals of approximately 50 cm.

Properties

The SIENOPYR duplex fiber-optic marine cable has the following properties:

- Ozone proof complying with DIN VDE 0472 Part 805 test type B
- Behavior in fire complying with IEC 60332-3 cat. A
- Corrosivity of combustion gases complying with IEC 60754-2
- Smoke density complying with IEC 61034
- Is free of halogens
- Is approved for ship building (GL, LRS, RINA)

Application

The SIENOPYR duplex marine fiber-optic able is intended for fixed installation on ships and offshore facilities in all enclosed spaces and on open decks. It is suitable for connecting optical ports operating at the wavelengths of 850 nm and 1300 nm.

5.2.5 Special Cables

Special Cables

In addition to the SIMATIC NET standard fiber-optic cables described in the Catalog IK PI, numerous special cables and accessories are also available. Listing all the versions available is beyond the scope of the catalog and of this manual.

The technical specifications of the SIMATIC NET bus components indicate which SIMATIC NET fiber-optic cable is the normal connecting cable and which other fiber types are suitable.

Note

Remember that the distances that can be covered differ if you use fibers with other core diameters or attenuation characteristics than those listed in the operating instructions.

Fiber Types

In addition to the standard SIMATIC NET fiber types, the following fiber types are often used:

- 50µm Fiber
  This fiber is used particularly in Europe in Telecom applications instead of the 62.5 µm fiber. The smaller core diameter means that less power can be coupled into the fiber and reduces the distance that can be covered.

Cable Structures

For special applications, numerous variations in the cable structure are available, for example:

- Bundled cores (cables with hollow cords capable of accommodating several fibers)
- Cables with rodent protection for underground installation
- Halogen-free cables, for example for use in underground train systems
- Hybrid cable with fibers and copper conductors in one sheath
- Certified cables, for example for use on ships

Ordering

If you require fiber-optic cables for particular applications, please contact your Siemens representative (see Appendix LEERER MERKER).

5.3 Connectors for Glass Fiber-Optic Cables

BFOC Connectors for Glass Fiber-Optic Cables

In Industrial Ethernet fiber-optic networks, only BFOC connectors are used for glass fiber-optic cables.

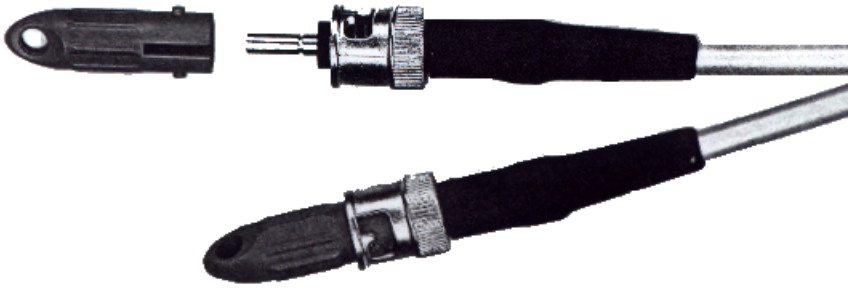

Figure 5-6 BFOC Connectors with Dust Caps

Fitting Connectors on Site

If it is necessary to fit connectors on site,
- SIEMENS provides this service (see Appendix LEERER MERKER)
- BFOC connectors and special tools can be ordered (see IK PI).

Note

Connectors should only be fitted to glass fiber-optic cables by trained personnel. When fitted correctly, they allow extremely low coupling attenuation and the value can be repeated after inserting the connector several times.

Preassembled Cables

To be able to use glass fiber-optic cables with untrained personnel, glass fiber-optic cables are also available with four BFOC connectors already fitted.

For ordering data, please refer to the current SIMATIC NET Catalog IK PI.

Caution

Fiber-optic cable connectors are susceptible to contamination and mechanical damage. Protect open connections with the supplied dust caps.

Note

Only remove the dust cap immediately before establishing the connection.

Active Components and Topologies

6

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6.1 Electrical and Optical Link Modules (ELM, OLM)

Figure 6-1 Industrial Ethernet OLM

Figure 6-2 Industrial Ethernet ELM

Overview

The SIMATIC NET link modules for Industrial Ethernet allow flexible configuration of Ethernet networks complying with the IEEE 802.3 standard using fiber-optic or copper cables. The transmission rate on all interfaces is 10Mbps. The link modules are fitted on to a standard rail.

The OLMs (Optical Link Modules) have three Industrial Twisted Pair (ITP) ports and two optical ports (BFOC). With ITP, up to three DTEs or further ITP segments can be connected; with fiber-optic cable, connection of up to two further DTEs or optical network components (OLM, star coupler with ECFL2 (Extension Card Fiber Link) etc.) are possible.

The ELMs (Electrical Link Modules) also have an AUI port in addition to the three Industrial Twisted Pair (ITP) ports. An Ethernet segment with triaxial cable can be connected to the AUI port via a 727-1 drop cable and a transceiver.

Both modules conform to the specifications of the IEEE 802.3 /1/ standard.

Note

Since the beginning of 1998, the Optical Link Module (OLM) is supplied as version 2.0. Version 2.0 includes the following improvements compared with the previous version:

- Redundancy control is not dependent on the load distribution in the network
- The diagnostic LEDs also indicate the segmentation of a port; this changed the display patterns of the link status LEDs (LS LEDs)
- The signal contact also indicates the segmentation of a port

The differences are explained in detail in the relevant sections in this manual.

Both versions are fully compatible and can be installed in a system in any combination.

The OLM version can be found on the type plate on the right-hand side panel (see Figure 6-3)

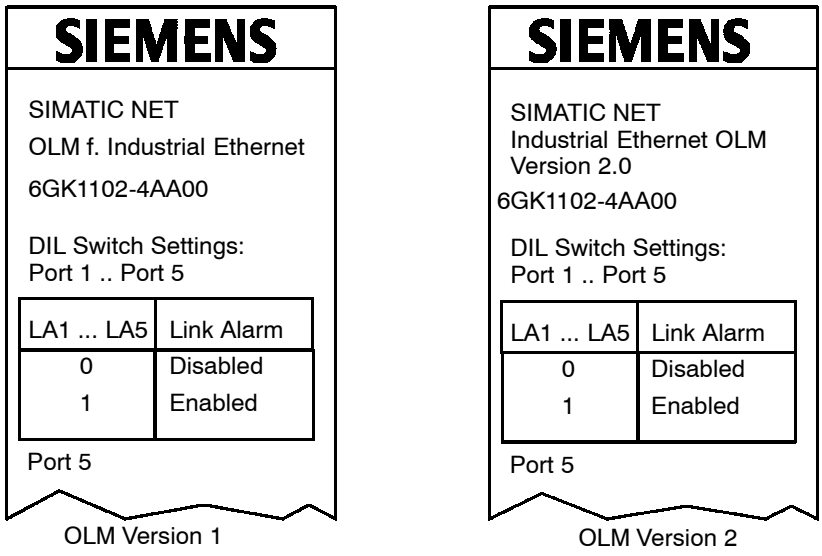


Figure 6-3 Type Plates of OLM Version 1 and Version 2.0

Warning

The OLM/ELM devices are designed for operation with safety extra-low voltage (SELV). This means that only safety extra-low voltages (SELV) complying with IEC 950/EN 60950/VDE 0805 may be connected to the power supply terminals and the signal contact.

6.1.1 Components of the Product

SIMATIC NET Industrial Ethernet OLM/ELM including

- Terminal block for the power supply
- Description and operating instructions

	Order number
SIMATIC NET Industrial Ethernet OLM	6GK1102-4AA00
SIMATIC NET Industrial Ethernet ELM	6GK1102-5AA00

6.1.2 Installation

The SIMATIC NET Industrial Ethernet OLM/ELM is clipped on to a standard rail. The modules can be installed vertically one beside the other without gaps. Unobstructed convection of the surrounding air must be assured, in particular, air must be able to circulate through the ventilation openings at the top and bottom.

6.1.3 Description of the Functions

6.1.3.1 General Functions

Signal Regeneration

The OLM/ELM regenerates the signal shape and amplitude of the received data.

Retiming

To prevent jitter increasing from segment to segment, the OLM/ELM retimes the data to be transmitted.

Preamble Regeneration

If preamble bits of received data are lost, the OLM/ELM pads out the preamble to 64 bits (including the start of frame delimiter (SFD)).

Fragment Extension

Short fragments can result from collisions. If the OLM/ELM receives a fragment, this is extended to a minimum length of 96 bits. This ensures reliable collision detection by all nodes.

Handling Collisions

If the OLM/ELM detects a data collision, it stops transmission. During the collision, the data packet that has collided is replaced by a jam signal (0/1 bit pattern) to ensure that the DTEs recognize the collision.

Auto Partitioning

A breakdown on the network can be caused by jabber lockup, wire breaks, missing terminating resistors, damaged cable insulation, and frequent collisions due to electromagnetic interference. To protect the network from these breakdowns, the OLM disconnects the segment from the remainder of the network in the receive direction.

On the OLM/ELM, this partitioning function operates separately for each port. You can continue to operate other ports without any problems if one of the ports has been partitioned. When a segment has been partitioned, the module continues to transmit to the ITP segment or to the optical fiber cable but reception at this port is disabled.

On twisted pair, the partitioning is active in the following situations:

- When a data collision lasts longer than 105 μs or
- more than 64 data collisions occur in succession.

On optical fiber cable, the partitioning is active in the following situations

- When a data collision lasts longer than 1.5 ms (normal mode) or 0.2 ms (redundant mode) or
- When more than 64 (normal mode) or 16 (redundant mode) data collisions occur in succession.

Reconnection

The segment is reconnected to the network as soon as a packet with the minimum length of 51 μs is received at the port where collisions were occurring; in other words when the segment is operating correctly again.

With the OLM version 2.0 in the redundant mode, packets longer than 51 μs sent without a collision occurring also lead to reconnection.

Jabber Lockup Protection

The network can be tied up continuously with data, for example due to a defective transceiver or LAN controller. To protect the network from this situation, the OLM/ELM stops reception as follows:

- At the ITP or AUI port affected after 5.5 ms.
  The interruption is canceled after an idle phase of 9.6 µs.
- At the fiber-optic port affected after 3.9 ms.
  The interruption is canceled after 420 ms of problem-free operation.

6.1.3.2 Functions Specific to the ITP Interface

Link Control

The OLM/ELM monitors the connected ITP line segments for short-circuits or breaks using regular link test pulses complying with the IEEE 802.3 10BASE-T standard. The OLM/ELM does not send data to an ITP segment from which it does not receive a link test pulse.

Note

An unused port is evaluated as a line break. The ITP link to a DTE that is turned off is also evaluated as a line break since the transceiver cannot send link test pulses without a power supply.

Auto Polarity Exchange

If the pair of receive lines is connected incorrectly (RD+ and RD– swapped over), the polarity is reversed automatically.

6.1.3.3 Functions Specific to the Fiber-Optic Interface

Standardization

The two fiber-optic ports on the underside of the OLM comply with the IEEE 802.3 standard: 10BASE-FL. These are implemented as two BFOC female connectors for connection of glass fiber-optic cables (62.5/125 μm or 50/125 μm). The operating wavelength is 850 nm.

Fiber-Optic Monitoring

The OLM monitors the connected ITP line segments for breaks using regular link test pulses. The OLM does not send data to a fiber-optic cable from which it is not receiving a link test pulse.

Redundancy

In areas in which data reliability is the most important factor, redundancy can ensure that data exchange is continued despite the breakdown of a fiber-optic cable or an OLM. Often a standby cable is installed in a different cable duct. If a fault occurs, data exchange is switched automatically from the main to the standby line.

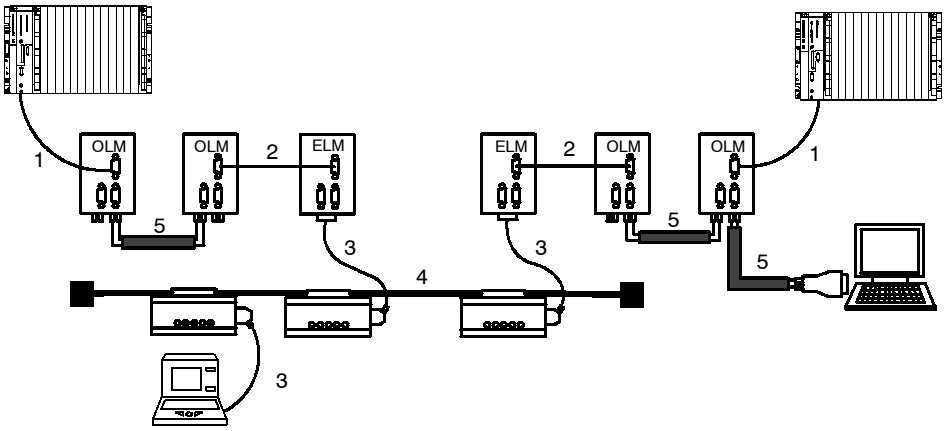
6.1.4 Topologies

A variety of topologies are possible with Industrial Ethernet OLMs and ELMs, as follows:

- Bus structure
- Star structure
- Redundant ring structure
- Combination of the basic structures listed above

Within these topologies, two structures (bus and redundant ring structure) can be considered as the basic structures.

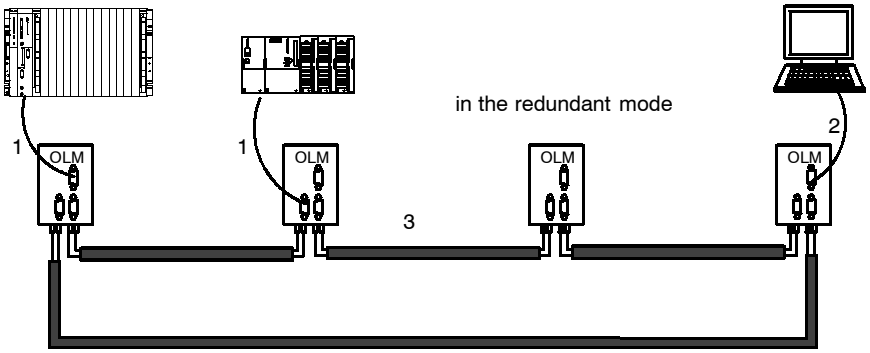
6.1.4.1 Bus Structure



1. ITP standard cable 9/15
2. ITP XP standard cable 9/9
3. 727-1 drop cable
4. Triaxial cable
5. Fiber-optic cable (FO)

Figure 6-4 Bus Structure with OLMs and ELMs

6.1.4.2 Redundant Ring Structure with Industrial Ethernet OLMs



1. ITP standard cable 9/15
2. TP cord 9/RJ-45
3. Fiber-optic cables

Figure 6-5 Redundant Ring with OLMs

For more detailed information about configuration and the way in which networks function with these topologies refer to the chapter “Network Configuration”.

Note

The modules in the redundant ring can only be connected to each other on fiber-optic cables.

6.2 Optical and Electrical Switch Modules (OSM/ESM)

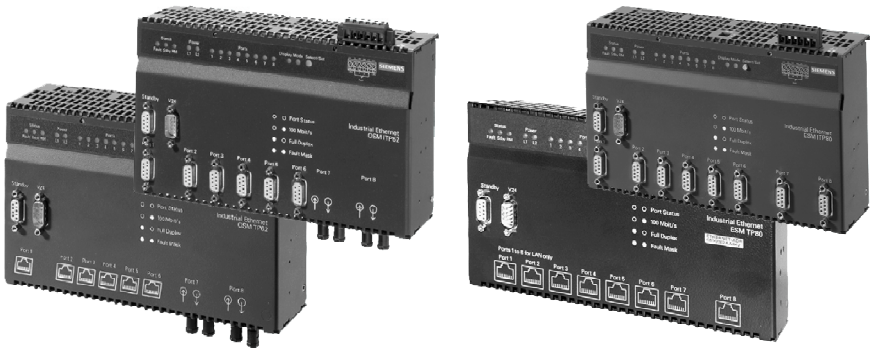


Figure 6-6 Optical/Electrical Switch Modules (OSM/ESM)

6.2.1 Application

Overview

The OSM/ESM Optical/Electrical Switch Modules, version 2 allow the cost-effective installation of switched networks operating at 100 Mbps.

By creating segments (dividing a network into subnets/segments) and attaching these segments to an OSM/ESM it is possible to contain the load in existing networks and to achieve an improvement in network performance.

The OSM/ESM allows you to create redundant Industrial Ethernet ring structures using switching technology with fast medium redundancy (reconfiguration time maximum 0.3 seconds).

To create an optical ring, OSMs with two FO ports are required.

To create an electrical ring, ports 7 and 8 of the ESM are interconnected using Industrial Twisted Pair cables.

The data rate in the ring is 100 Mbps; a maximum of 50 OSMs/ESMs can be used.

In addition to the two ring ports, OSMs/ESMs have a further six ports (optionally sub-D or RJ-45 ports), to which both DTEs and network segments can be attached.

Several rings can be interconnected redundantly using the integrated standby function.

There are three ways of signaling errors:

- via the signal contact
- via SNMP (traps)
- by E-mail

6.2.2 Design

Casing, Installation

The Industrial Ethernet OSM and ESM has a sheet steel casing with degree of protection IP20. They are suitable for the following types of installation:

- Installation on a 35 mm DIN rail
- Installation on a SIMATIC S7-300 rail
- Installation in pairs in a 19” cubicle
- Wall mounting

The modules can be installed vertically, one beside the other without gaps. Unobstructed convection of surrounding air is essential, in particular air must be able to circulate freely through the ventilation openings of the OSM/ESM.

Ports

All modules have a 6-pin terminal block for connecting the power supply (redundant 24 V DC power supply) and the floating signal contact.

The mode and status information are displayed by a row of LEDs and a selection button.

The Standby-Sync port is used to synchronize two modules when linking redundant networks.

The OSMs/ESMs can be upgraded to new firmware revisions and can be assigned parameters via the serial port.

The OSM/ESM has a total of eight LAN ports. Depending on the particular variant, they have the following ports:

- Twisted-pair port (sub-D): 10/100BASE-TX
  9-pin sub-D female connector (ITP port), automatic data rate detection (10 or 100 Mbps) for connection of TP cables (max. length 100 m)
- Twisted-pair port (RJ-45): 10/100BASE-TX
  RJ-45 jack, automatic data rate detection (10 or 100 Mbps) for connection of TP Cords (max. length 10 m, in conjunction with FC Outlets RJ-45 and Industrial Ethernet FastConnect cable (patch cabling) up to 100 m)
- Glass FOC: multimode (MM); 100BASE-FX BFOC
  2 BFOC sockets per port, data rate 100 Mbps, for connection of multimode FOC in environments with high EMI levels and for distances up to 3000 m between two OSMs
- Glass FOC: single mode (SM); 100BASE-FX BFOC
  2 BFOC sockets per port, data rate 100 Mbps, for connection of single mode FOC in environments with high EMI levels and for distances up to 26 km between two OSM ITP62-LD modules

6.2.3 Functions

Increased Network Performance

By filtering the data traffic based on the Ethernet (MAC) address of the DTEs, local data traffic remains local, only data intended for nodes in another subnet is forwarded by the OSM or ESM.

Simple Network Configuration and Network Expansion

A total network span of up to 150 km (OSM) or 5 km (ESM) presents no problem. OSMs and ESMs store the data received at the ports and then direct it to the destination address. The restriction of the network span resulting from collision detection (CSMA/CD) ends at the OSM/ESM port.

Error Containment

The OSM/ESM limits the propagation of errors in a network to the subnet involved because it forwards only valid data.

Integration of Ethernet Networks Operating at 10 Mbps and 100 Mbps

The OSM/ESM is suitable for the integration of existing subnets operating at 10 Mbps in Fast Ethernet networks operating at 100 Mbps.

The OSM/ESM automatically detects the data rate (10 or 100 Mbps) at the twisted-pair ports as well full or half duplex operation.

Fast Redundancy in the Ring

By interconnecting the ends of a bus using OSMs/ESMs to form a ring, reliable communication can be achieved. With an OSM/ESM in the ring, the integrated redundancy manager is activated using a DIP switch. The redundancy manager constantly monitors the operation of the network.

It recognizes the failure of a section in the ring or of an OSM/ESM and activates the substitute path within a maximum of 0.3 seconds.

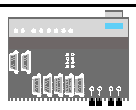
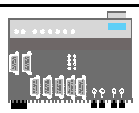
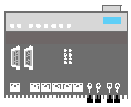
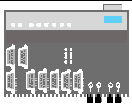
Redundant Linking of Networks

The standby function integrated in the OSM/ESM allows the redundant linking of two networks (ring or bus). To achieve this, two OSMs/ESMs are set as the standby master/slave using a DIP switch in each network and their standby ports connected to the corresponding OSM/ESM in the other network.

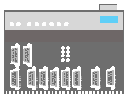
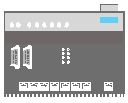
Priority for Forwarding Time-of-Day Frames

OSMs/ESMs recognize a SIMATIC NET time-of-day frame by its multicast address $09000601FFEF_H$ and forward it with priority over other frames. Giving priority to time-of-day frames minimizes their propagation time in the network and keeps this as low as possible regardless of the network load.

Variants of the OSM

Product		Sub-D 9-pin	RJ-45	Multimode FOC (MM)	Single mode FOC (SM)
	OSM ITP62	6	–	2	–
	OSM ITP53	5	–	3	–
	OSM TP62	–	6	2	–
	OSM ITP62-LD	6	–	–	2

Variants of the ESM

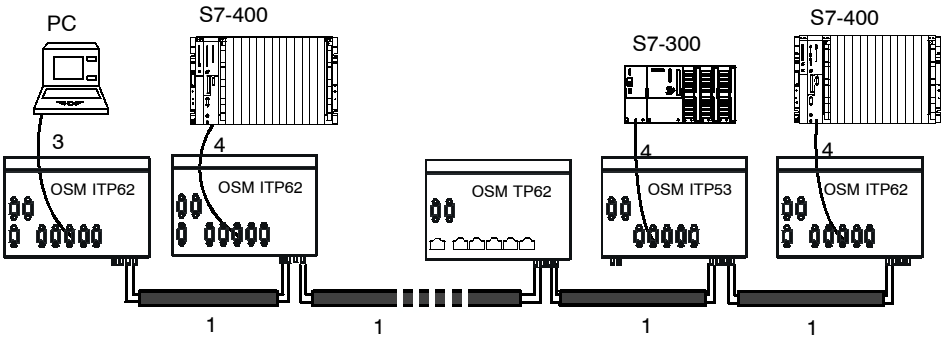
Product		Sub-D 9-pin	RJ-45
	ESM ITP80	8	–
	ESM TP80	–	8

6.2.4 Bus Topologies with the OSM/ESM

Bus Structure

Bus structures can be implemented with OSMs/ESMs. The maximum cascading depth is 50 OSMs/ESMs in series.

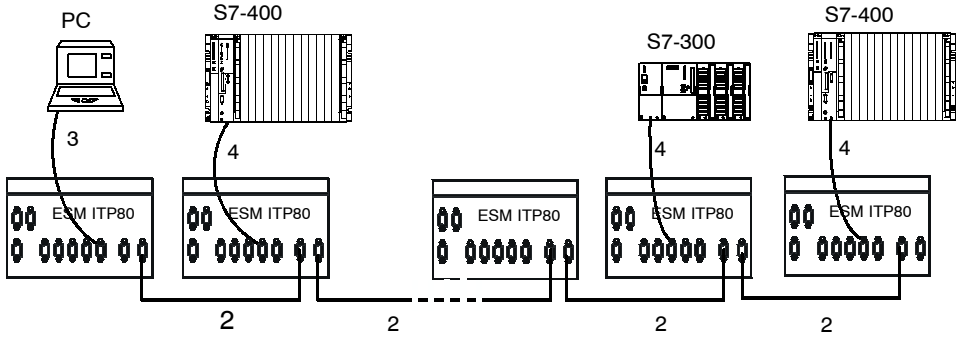
The entire segment lengths permitted for a port type (TP, FO) can be used.



1 Fiber-Optic Cable (FO)
3 TP cord 9/RJ-45
4 ITP standard cable 9/15

Figure 6-7 Bus with OSMs

Apart from OSM ITP62-LD modules, all listed OSM variants can be used in any combination in a bus consisting of OSMs. OSM ITP62-LD modules can only be coupled with other OSM ITP62-LD modules via the optical ports (monomode fiber).



2 ITP XP standard cable 9/9
3 TP cord 9/RJ-45
4 ITP standard cable 9/15

Figure 6-8 Bus with ESMs

In a linear bus structure consisting of ESMs, you can use both ESM ITP80 modules as well as ESM TP80 modules (cables for linking the two variants are available on request).

6.2.5 Redundant Ring Structure

Redundant Ring Structure with OSMs

With the aid of an OSM functioning as the redundancy manager (RM), the ends of an optical bus made up of OSMs can be connected together to form a redundant optical ring. The OSMs are connected together using ports 7 and 8.

The RM monitors the OSM bus connected to it at ports 7 and 8 in both directions. If it detects a break on the bus, it interconnects the ends of the bus to reestablish a functioning bus configuration. A maximum of 50 OSMs are permitted in an optical ring. This strategy achieves a reconfiguration time of less than 0.3 seconds.

The RM mode is activated on the OSM using a DIP switch.

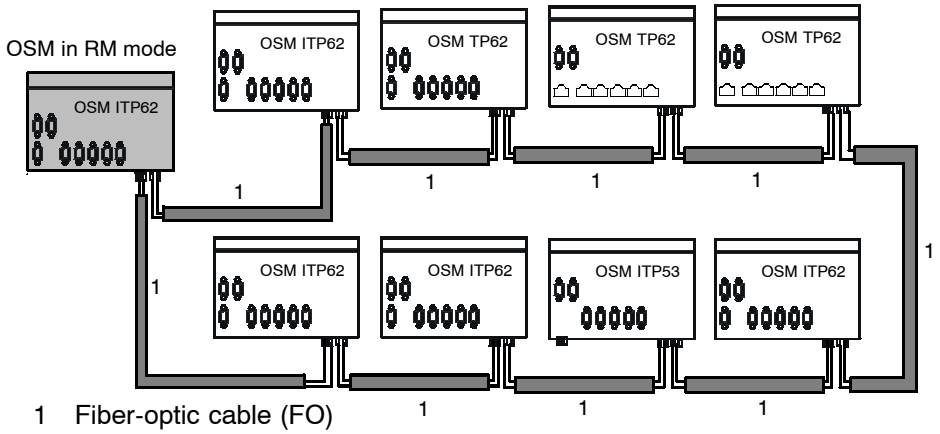


Figure 6-9 Redundant Ring Structure with OSMs

Redundant Ring Structure with ESMs

A redundant electrical ring can be established using ESMs in the same way. To achieve this the ESMs are connected together using ports 7 and 8. One device must be switched to the redundancy manager mode. With ESMs and a maximum of 50 devices in the ring, a reconfiguration time of less than 0.3 s can also be achieved.

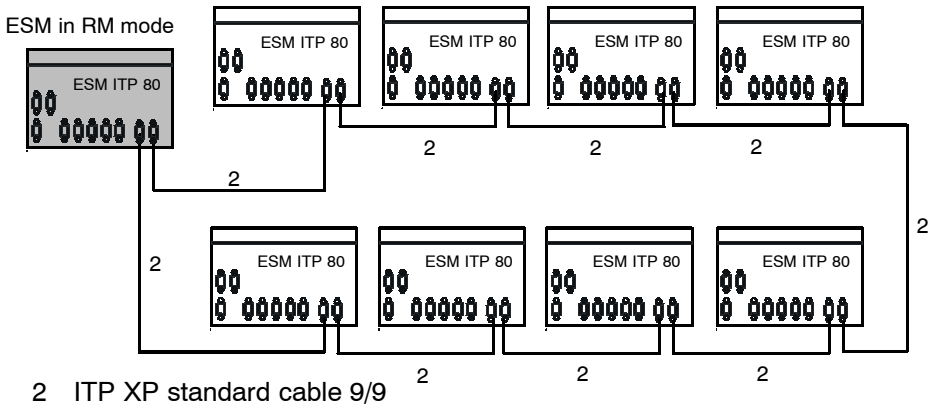


Figure 6-10 Redundant Ring Structure with ESMs

Note

The reconfiguration time of less than 0.3 s can only be achieved when no components (for example switches from other vendors) other than OSMs or ESMs are used in the redundant ring.

In a ring, one device and one device only must operate in the redundancy manager mode.

DTEs or complete network segments can be attached to ports 1 – 6 of an OSM/ESM operating in the RM mode.

6.2.6 Linking Subnets Using the OSM/ESM

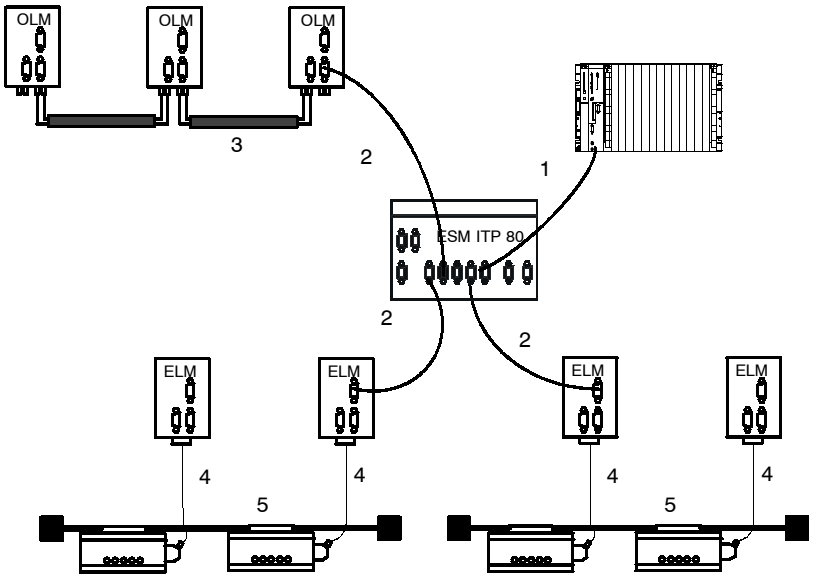
Subnets

Using the OSM/ESM, it is possible to link several different Ethernet networks together. The collision domain of a subnet ends at the port of the OSM/ESM.

OSMs/ESMs are ideal for structuring larger networks. Large networks are first divided into smaller units (subnets). These subnets are then connected to the OSM/ESM that not only interconnects them but also separates them in terms of load. The time and effort required for network configuration and expansion is considerably reduced.

Network Expansion

Selectively forwarding data to the addressed nodes contains the load in the subnets/segments. Discarding bad data also brings about a further improvement in network performance.
These properties make the OSM/ESM the ideal tool for expanding conventional Ethernet networks that have otherwise reached their limits.



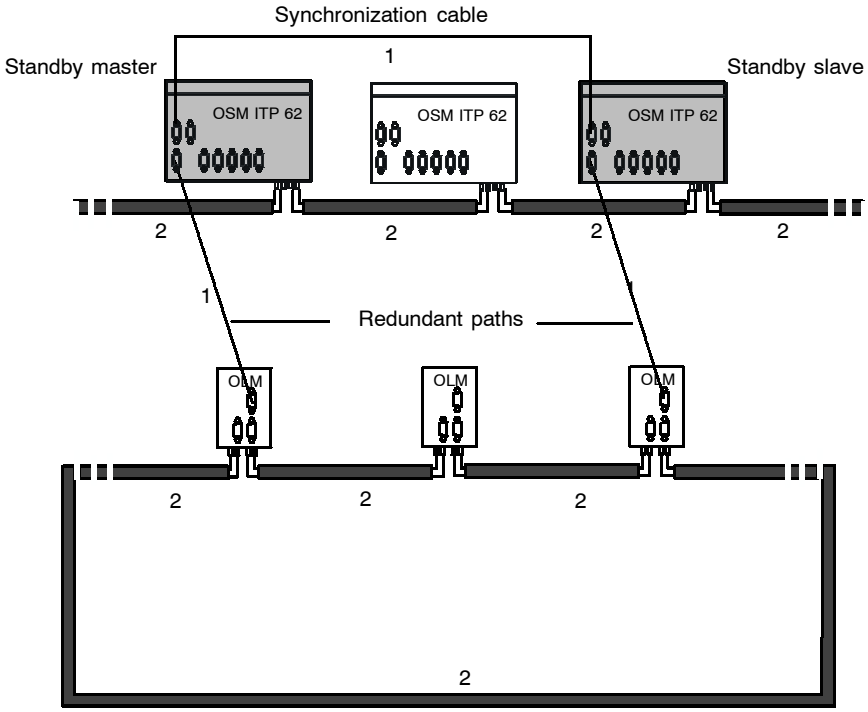
1 ITP standard cable 9/15
2 ITP XP standard cable 9/9
3 Fiber-optic cable (FO)
4 727-1 drop cable
5 Triaxial cable

Figure 6-11 Linking Several Collision Domains/Subnets Using an ESM

6.2.7 Redundant Linking of Subnets Using the OSM/ESM

Structure of a Redundant Link

Using an OSM/ESM, fast, redundant links between two Ethernet subnets or networks can be implemented. These networks can, for example, consist of redundant OSM/ESM rings.
The redundant link as shown in Figure 6-12 is established on separate paths via the two TP ports (port 1) of an OSM/ESM pair. The standby-sync ports of both OSMs/ESMs must be connected using an ITP XP standard cable 9/9 with a maximum length of 40 m.



1. ITP XP standard cable 9/9
2. Fiber-optic cable (FO)

Figure 6-12 Redundant Link Between Two Networks or Network Segments

How Standby Redundancy Works

One of the two OSMs/ESMs must be set to the standby mode by setting the DIP switch. This OSM/ESM forms the redundant link that only transfers data when the other path (main link) fails. The OSM/ESM in the standby mode receives information about the state of the main link via the synchronization connection between the standby-sync ports. If the main link fails, the redundant OSM/ESM activates the standby link within 0.3 seconds.
If the problem is eliminated on the main link, this also causes a signal on the synchronization connection. The main link is enabled again and the standby link disabled.

Faults Managed by the Redundancy Function

The following problems on the main link activate the standby link:

- Main OSM/ESM without power
- Cable break at a cascaded port of the main OSM/ESM
- Defective or deactivated partner on a cascaded port of the main OSM/SM.

6.2.8 Components of the OSM/ESM

SIMATIC NET Industrial Ethernet OSM/ESM including

- Terminal block for the power supply
- Fittings for wall mounting
- Product information bulletin
- CD with Operating Instructions and “Network Management” Manual

	Order number
SIMATIC NET Industrial Ethernet OSM	See catalog IK PI
SIMATIC NET Industrial Ethernet ESM	See catalog IK PI

Accessories

SIMATIC NET ITP Standard Cable
SIMATIC NET ITP XP Standard Cable
SIMATIC NET FIBER OPTIC Glass FOC
SIMATIC NET TP Cord
SIMATIC NET FC Outlet RJ-45
SIMATIC NET FC TP Cables

For ordering data, refer to catalog IK PI.

Warning

The Industrial Ethernet OSM/ESM is designed for operation with safety extra-low voltage (SELV). This means that only safety extra-low voltages (SELV) complying with IEC 950/EN 60950/VDE 0805 may be connected to the power supply terminals or the signaling contact.

For more detailed information on the OSM/ESM, refer to the “Industrial Ethernet OSM/ESM” operating instructions in the appendix of this manual.

6.2.9 Network Management of the OSM/ESM

Functions

Network management provides the following functions:

Password protected login for administrators (write and read rights) and users (read rights only)

- Reading out version and status information
- Setting the message and standby mask and address information
- Fixed parameter settings for ports and filter tables
- Output of statistical information
- Diagnostics of data traffic via a selectable mirror port
- Downloading new firmware versions via the network

If problems occur in the network, the OSM/ESM can send error messages (traps) automatically to a network management system or E-mails to a network administrator.

Remote Monitoring

Remote monitoring (RMON) provides the following functions:

The OSM/ESM is capable of visualizing statistical information according to the RMON Standards 1 to 3. These include, for example, error statistics maintained for each port separately.

Web-Based Management Functions

The management level of the OSM is accessible using a Web browser. Masks, filters, and ports can be configured. Diagnostics of the device and the ports is possible via the Web.

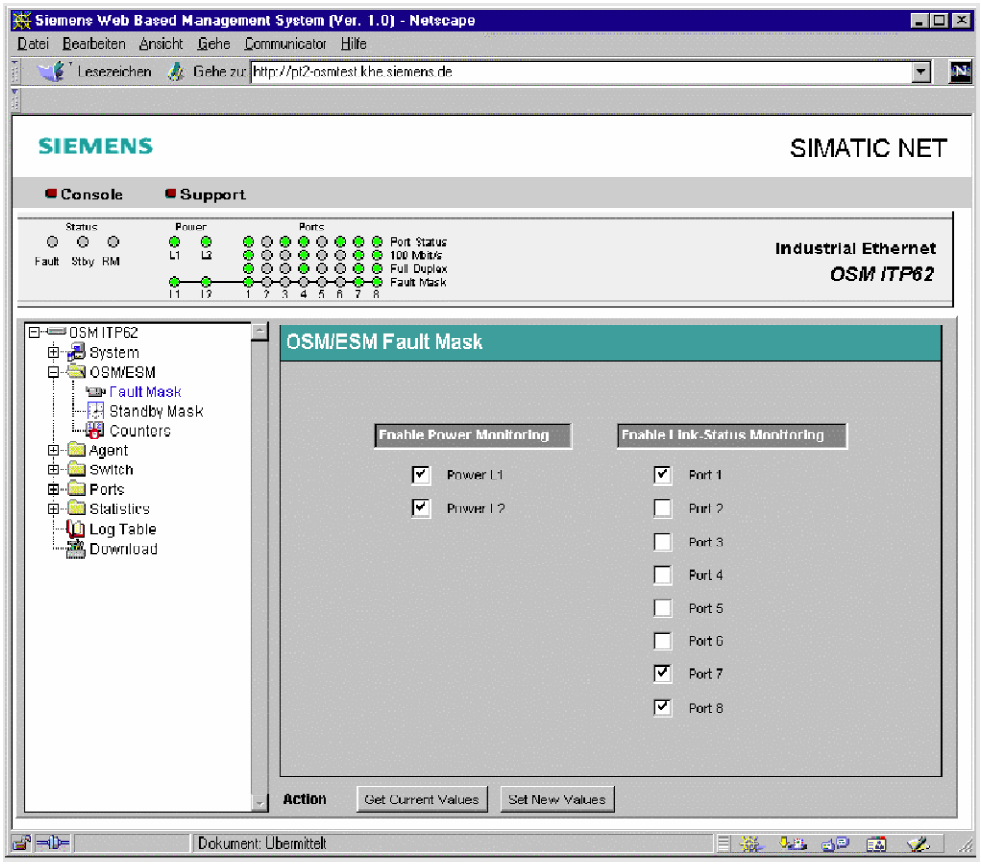


Figure 6-13 Network Management with Web Browser

6.3 ASGE Active Star Coupler

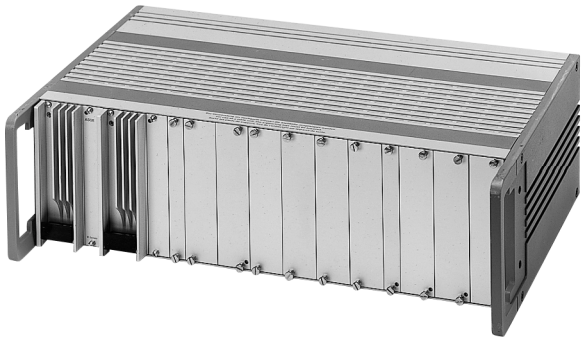


Figure 6-14 Star Coupler ASGE

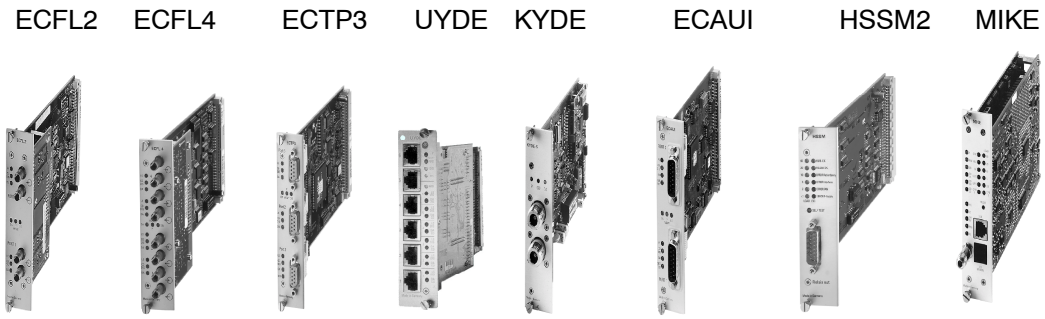


Figure 6-15 Interface Cards for the Star Coupler ASGE

The active star couplers form the branching points on a 10 Mbps network using the CSMA/CD access protocol complying with IEEE 802.3. The modular concept allows a flexible network structure with various transmission media such as triaxial cable (727-0 bus cable), Industrial Twisted Pair cable, fiber-optic cable (FO) or drop cables (727-1).

The star coupler has the following properties and functions:

- Strong construction with die-cast aluminum housing
- Can be used as a desktop unit or in a 19” cabinet
- Interface cards available for various transmission media and applications
- Easy servicing by replacing interface cards during operation
- Monitoring with HSSM 2 signaling card
- SNMP management capability with MIKE management card
- Also available as 24 V version
- Redundancy concepts possible with ring topology using fiber-optic cable

Note

For more detailed information about the ASGE star coupler, refer to the SIMATIC NET Catalog IK PI and the Ethernet manual (English, order number: HIR: 943320-011, German, order number: HIR: 943320-001).

6.4 MINI OTDE Optical Transceiver

6.4.1 Overview

Figure 6-16 MINI OTDE Optical Transceiver

Areas of Application

The MINI OTDE optical transceiver is used to connect a DTE with an AUI port to an optical network and to establish a fiber-optic link between two DTEs. The MINI OTDE provides electrical isolation with the fiber-optic cable (FO). This results in immunity to electromagnetic interference. The optical transceiver can be plugged directly into the AUI port of the DTE. If the module is fixed using the wall mounting, the MINI OTDE can be connected to the DTE using the 727-1 drop cable. The major advantages of the MINI OTDE optical transceiver are its small dimensions and compact design.

The optical port of the MINI OTDE is implemented as two BFOC/2.5 female connectors (ST compatible). A glass fiber-optic cable with graded fibers (Type 62.5/125 μm fibers) can be connected.

Note

Removing and reinserting the MINI OTDE with the power supply turned on can lead to disturbances on the DTE (for example restarting a PC).

Note

For more detailed information on the MINI OTDE optical transceiver, refer to the SIMATIC NET Catalog IK PI and the Ethernet manual (English, order number: HIR: 943320-011, German, order number: HIR: 943320-001).

6.4.2 The Product and Ordering Data

The MINI OTDE optical transceiver is supplied in the BFOC version:

	Order number
MINI OTDE optical transceiver	HIR: 943303-021

Accessories

	Order number
Wall holder for Mini OTDE and Mini UTDE (five mountings per package)	HIR: 943426-001

6.4.3 Functions

The MINI OTDE optical transceiver has the following properties and functions:

- The optical transceiver converts the electrical signals of a node with an AUI port (complying with IEEE 802.3) into the optical form required for the fiber-optic cable.
- The optical port complies with the specification IEEE 802.3; 10BASE F /4/ and operates at a wavelength of 860 nm.
- It allows the attachment of DTEs, fan-out units, repeaters, and ELMs to an optical transmission path and connects two DTEs via fiber-optic cable.
- An optical link segment can be created using an optical transceiver and fiber-optic cable.
- It is also possible to connect the MINI OTDE to a DTE using the 727-1 drop cable.

6.4.4 Topologies with the MINI OTDE

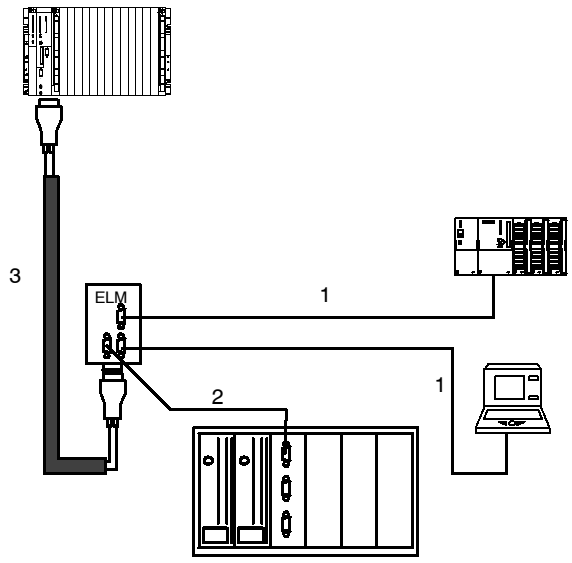
Two applications of the MINI OTDE are illustrated below:

- Point-to-point link between two DTEs on a fiber-optic cable
- Attachment of subnets and DTEs to an optical network

Point-to-Point Link with Fiber-Optic Cable

Figure 6-17 Point-to-Point Link

Attachment of Subnets and DTEs to an Optical Network



1. TP cord 9/RJ-45
2. ITP XP standard cable 9/9
3. Fiber-optic cable (FO)

Figure 6-18 Attachment of Subnets and DTEs

6.5 Mini UTDE Electrical Transceiver (RJ-45)

6.5.1 Overview

Figure 6-19 Mini UTDE Electrical Transceiver (RJ-45)

Areas of Application

The twisted pair MINI UTDE RJ-45 transceiver is used to connect a DTE with an AUI port to a twisted pair network and to establish a twisted pair link between two DTEs with AUI ports.

The Mini UTDE RJ-45 can be plugged directly into the AUI port of the DTE.

Fixed installation with a wall holder is also possible. The Mini UTDE RJ-45 is then connected to a DTE using the 727-1 drop cable.

Note

Removing and reinserting the MINI UTDE with the power supply turned on can lead to disturbances on the DTE (for example restart on a PC).

Note

For more detailed information on the MINI UTDE electrical transceiver, refer to the SIMATIC NET Catalog IK PI and the Ethernet manual (English, order number: HIR: 943320-011, German, order number: HIR: 943320-001).

6.5.2 The Product and Ordering Data

Ordering Data:

The electrical transceiver Mini UTDE RJ-45 Industrial Ethernet Twisted Pair Transceiver can be ordered as follows:

	Order number
Electrical Transceiver Mini UTDE RJ-45	HIR:943 270-002
Wall holder (accessories) for Mini UTDE and OTDE (pack of 5)	HIR:943 426-001

6.5.3 Functions

The twisted-pair Mini UTDE RJ-45 transceiver has the following features and functions:

- Specification complying with IEEE 802.3, 10BASE-T /3/.
- It allows the attachment of DTEs with an AUI port, repeaters or ELMs to a twisted-pair transmission path and connects two DTEs via twisted pair.
- The twisted pair transceiver converts the electrical signals of a node with an AUI port complying with IEEE 802.3 into the electrical signals of a twisted-pair port.
- It is also possible to connect the Mini UTDE RJ-45 to a DTE using the 727-1 drop cable.

6.5.4 Topologies with the Mini UTDE RJ-45

Figure 6-20 shows the linking of a node with an AUI port to a twisted pair network as an example of the twisted pair transceiver
Mini UTDE RJ-45.

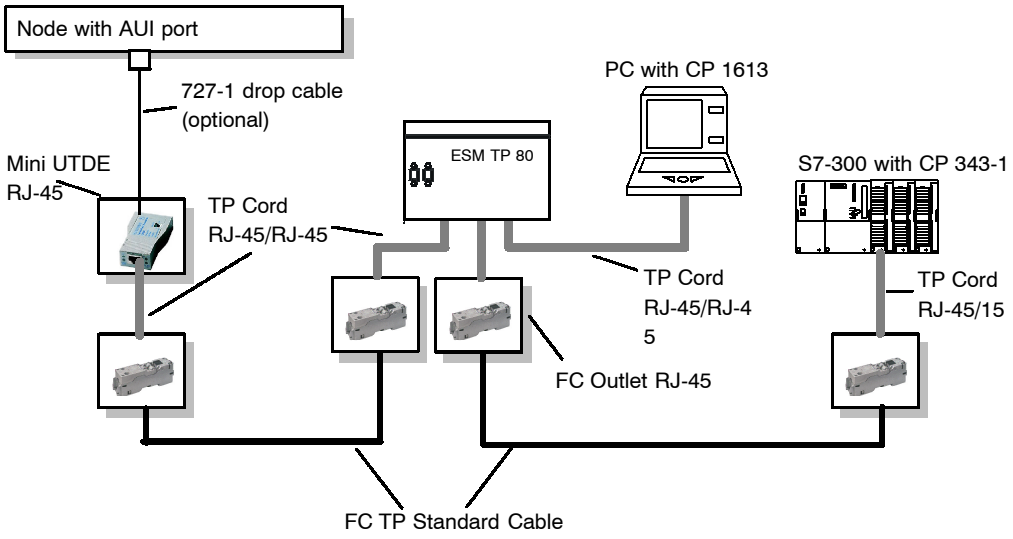


Figure 6-20 Example of a Link with the Mini UTDE RJ-45

Guidelines for Installing Networked Automation Systems in Buildings

7

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7.1 General Instructions on Networking with Bus Cables

Bus (LAN) Cables in Plants

Bus cables are important connections for communication between individual components of an automation system. Mechanical damage or repeated electrical interference affecting these bus connections reduces the transmission capacity of the system. In extreme cases, such problems can lead to failure of the entire automation system. This section explains how to protect cables from mechanical and electrical impairment.

Shielding and Grounding Concept

Bus cables connect programmable controllers. These in turn are connected to transducers, power supply units, peripheral devices etc. over cables.

All the components together form a complex electrically networked automation system.

When connecting system components via electrical cables (in this case bus cables), remember to take into account the requirements of the overall system structure.

Connecting cables, in particular, influence the shielding and grounding concept. Shielding and grounding an electrical installation serves the following purposes:

- Protects both humans and animals from dangerous network voltages
- Prevents unacceptable noise emission and susceptibility to noise
- Protects the system from overvoltage (for example lightning protection)

Networking SIMATIC with SIMATIC NET

SIMATIC NET network components and SIMATIC automation components are designed to operate together taking into account the aspects listed above. By keeping to the installation instructions described in the system manuals, your automation system will meet the legal and normal industrial requirements for safety and noise immunity.

7.2 Protection from Electric Shock

Twisted-Pair Signal Level

The signal levels on twisted pair cables are low voltage. Correctly installed and operated twisted pair bus cables do not have dangerous electrical voltages.

Nevertheless you should remember the following rules when installing the power supply for all components (DTEs, bus components, etc.) that you want to connect to twisted-pair cable.

Operation with 24 V DC

Numerous SIMATIC NET components require a voltage of 24 V DC as their operating voltage or as auxiliary contact voltage. This power supply must meet the requirements of an extra-low voltage with reliable electrical isolation from the main power system, complying with IEC 60950 or EN 60950 /18/.

Operation with Live Voltage

Components operated with live voltage must meet the requirements for protection against electric shock as stipulated in EN 60950 /18/, EN 61131-2 /20/, EN 61010 /19/ or other applicable product standards.

All the signals of the twisted-pair port must meet the requirements of reliable electrical isolation from the main power supply, complying with IEC 60950 or EN 60950 /18/.

Cabling Components

Conductive cable path systems, barriers, and accessories must be included in the protective measures preventing indirect contact (protection against illegal dangerous contact voltage).

Grounding conductors (PE) and equipotential bonding conductors must be installed according to the requirements of systems in buildings complying with HD 384.4.41 (protective measures against electric shock) and HD 384.5.54 (grounding and grounding conductor). The application of EN 50174-2 is recommended for the separation of low voltage cabling and IT cabling.

The requirements of HD 384.4.47 S2 (application of measures for protection against electric shock) and HD 384.4.482 S1 (selection of protective measures as a function of external influences) and appropriate national or local regulations must be adhered to.

Safe Initial State of the System in Case of Faults

Problems on communication connections must not be allowed to put system users at risk. Cable or wire breaks must not lead to undefined statuses in the plant or system.

7.3 Electromagnetic Compatibility of Bus Cables

Electromagnetic Compatibility (EMC)

Electromagnetic compatibility (EMC) is the capability of an electrical installation to function satisfactorily in its electromagnetic environment without influencing this environment and interfering with other installations and equipment belonging to it (in compliance with DIN VDE 0870).

This mutual influence can take the form of electrical, magnetic, and electromagnetic effects. These effects can spread both over cable connections (for example a common power supply) or due to radiated interference.

To avoid external interference affecting electrical systems, these effects must be reduced to a certain level. The measures involved include the design, structure, and correct connection of bus cables. The components and bus cables for SIMATIC NET Industrial Ethernet meet the requirements of the European standards for devices used in an industrial environment. This is documented by the CE marking.

Note

Adherence to the specified limit values can only be guaranteed when using components from the SIMATIC NET Industrial Ethernet range exclusively and by keeping to the installation instructions in this manual!

7.3.1 Measures to Counter Interference Voltages

Overview

Measures are often taken to suppress interference voltages when the control system is already in operation and problems occur receiving signals. You can normally reduce the investment necessary for later restructuring of the system by remembering the following points when installing your automation system.

- Setup an equipotential bonding system including all inactive metal parts
- Include a power distribution system with non-current PE grounding conductor (for example using the TN-S system)
- Include shielding devices and bus cables
- Position devices and route cables suitably
- Take special noise suppression measures

The list shows that installing an interference-free networked automation system simply with the tools for bus cable installation is not adequate. Measures must already be taken during the planning phase of a system or building to ensure harmony between all the equipment that requires electrically conductive connections. Such measures include metallic structures in the building, conduits for supply installations (gas, water, ventilation), as well as the electrical power supply.

Standards for the Installation of Noise-Free Information Technology Systems

Based on the points outlined above, the standards committees of the European Union formulated European standards for satisfactory installation and satisfactory operation of information technology cabling within the infrastructure of a building in which a power distribution system is operated at an effective value less than AC 1000 V (EN 50174).

The term “information technology” cabling/system includes all devices and cables that transmit or process information electronically. The resulting standards can therefore also be applied to automation systems.

Adherence to the standards when installing communication cabling (EN 50174, /12/, /13/, /14/ series) and the requirements for bonding (EN 50310, /21/) is strongly recommended. There are currently no international standards to compare with these European standards in terms of detail.

The standards for the design of communications cabling (EN 50098, EN 50173, /11/ series) are intended for applications in an office environment but nevertheless include useful information for industrial applications.

7.3.2 Equipotential Bonding System

Aims of Bonding

The noise immunity of extended electronic automation systems or, in general, information technology systems largely depends on the suitable design of the grounding and bonding system of the building.

Equipotential bonding and grounding have two essential aims:

- Protection from the dangers of electricity
  - by limiting the contact voltage and creating a fault to ground path
- Improvement of electromagnetic compatibility
  - by creating a reference potential and equalizing potential differences between parts of the system
  - by shielding

Causes of Potential Differences

Wherever electric currents flow, magnetic fields are produced that in turn induce stray currents in electrically conductive materials. Induced stray currents can therefore not be avoided in the vicinity of electrical consumers (drives, electronic controls, lighting etc.) and their power supply cables. They spread in all conductor loops. Conductor loops are formed by parts of buildings such as metal bannisters on staircases, water pipes or central heating pipes as well as through the shields of electrical data cables and the protective ground connectors of electrical devices (PE). The flow of current produces a voltage drop. This can be measured as a potential difference between two locations within the system.

Extremely high potential differences between two grounding points result from lightning strikes.

Effects of Potential Differences in Information Technology Systems

If locations with different grounding potential are connected via cables, currents will flow. The currents flow on all connections between these two points, for example also on the signal cables or cable shields connecting them. Attached devices can be disturbed or even destroyed.

The aim of a grounding and bonding system is to ensure that the currents flow in the grounding system and not in the electronic circuits.

Measures for Grounding and Equipotential Bonding

According to EN 50310 /21/, a “common bonding network CBN” with a fine mesh of conductive elements must be created in buildings with information technology systems. Systems that extend beyond one floor and that are interconnected by electrical bus cables require a three-dimensional CBN with a lattice construction resembling a Faraday cage.

With the following measures, you can create a grounding and bonding system that will improve EMC:

- Include all the metal parts of a building in a common bonding network (CBN) with low impedance and high current carrying capacity. To this network, you should then connect the main grounding terminal or bar, grounding conductors, metal conduits, reinforcing rods, equipotential bonding ring conductor, cable racks and any additional bonding conductors.
- Connect all inactive metal parts in the immediate vicinity of your automation components and bus cables to the bonding system ensuring good conductivity. This includes all metal parts of cabinets, machine parts etc. that have no electrical function in the automation system.
- Include metal, conducting cable channels/racks in the equipotential bonding of the building and between the individual parts of the system. The individual segments of the channels/racks must be connected together with low inductance and low resistance and connected to the CBN system as often as possible. Expansion joints and angled connections should be bridged by additional flexible grounding bands. The connections between the individual segments of channels must be protected from corrosion to ensure long-term stability.
- The effectiveness of equipotential bonding is greater when the impedance of the bonding conductor is low.
- The impedance of the additional bonding conductor must not exceed 10% of the shield impedance of parallel Industrial Twisted Pair cables.
- Protect the bonding conductor from corrosion.
- Install the bonding conductor so that the area enclosed by the bonding conductor and signal cables is as small as possible.
- Use copper or galvanized steel for the bonding conductor.

For information about grounding and bonding techniques, refer to the system manuals of the SIMATIC S7-300 /9/, S7-400 /10/ programmable controllers.

Note

Equipotential bonding is unnecessary if the sections of a system are connected exclusively using fiber-optic cable (FO).

7.3.3 Requirements of the Power Distribution System

General

HD 384.3 S2 (IEC 60364-3:1993, modified, /22/) describes various power distribution systems (TN-S, TN-C,S, TN-C, TT and IT systems). Additional national or local regulations stipulate the measures required for protection from electric shock and stipulate the requirements for a grounding system (see also section 7.2 protection from electric shock).

The outer surfaces of switching cubicles, device casings, connectors and bus cables are conductive to provide shielding and must be connected to the grounding system to ensure safety. To ensure that the EMC shield effect is achieved, they make further requirements of the grounding system and grounding of the power distribution system. These result in an alternating power distribution system with non-current carrying grounding conductors, for example as in the TN-S system.

Cable shields are part of the equipotential bonding network of a system.

Since the shields of twisted-pair cables are included in the bonding system, all the currents coupled into the bonding system of a building or plant flow through them.

Depending on the intensity and frequency range, these shield currents can cause disturbances in data communication. Measures must therefore be taken to avoid the alternating power distribution system of a plant including the bonding system in the power return cabling. A TN–S system with separate cables or N and PE, for example, meets these requirements. The EN 50310:2000 /21/ standard provides detailed guidelines for installing a network system for supplying information technology equipment.

Note

DTEs and /or network components connected over shielded twisted-pair cables must only be supplied by alternating power distribution systems whose grounding conductors cannot contribute to the transmission of energy. There must be no PEN cable within the entire system. This condition is met, for example, by a TN-S system.

Signal Connections in Existing Installations

If unexplained, sporadic disturbances occur in data processing systems or on their communication connections, it is advisable to check for unwanted shield currents. These can be measured simply by inserting the cable in question in a clip-on ammeter. Currents higher than approximately 0.1 A indicate problems in the electrical installation, for example in the TN-C system.

If the alternating current power system supplies a large number of electronic devices or electronically controlled consumers the highest interference currents can generally be observed at the third harmonic of the frequency.

Other signs of an unsuitable alternating current power supply are as follows:

- Currents on the PE conductor
- Currents through water pipes and heating pipes
- Progressive corrosion at grounding terminals, on lightning conductors, and water pipes.

Remember that sporadic events such as switching, short circuits, or atmospheric discharge (lightning strike) can cause current peaks in the system many times higher than the average value.

Troubleshooting

The following measures are suitable for trouble shooting:

- Restructuring the power distribution system (to form a TN-S system)
- Replacing the electrical data cabling with fiber-optic cables
- Installing an equipotential bonding conductor parallel to the disturbed data cabling.

Note

If shield currents on bus cables cause problems in communication, the safest often cheapest solution is to replace the disturbed electrical bus connection with a fiber-optic cable.

Help with structuring noise-free power supply systems

You will find the addresses of Siemens departments that will help you in the planning and installation of noise-free power supply installations for information-technology systems or in the detection and elimination of existing installation errors in the appendix of this manual.

Example of Installing FOC in a TN-C-S System

Figure 7-1 illustrates the relationships between the structure of the alternating current network, equipotential bonding system, and information technology cabling in a building.

Three PCs and three S7-300 PLCs represent the information technology system. These are networked using two OSMs. The casing of all the DTEs and the OSMs are correctly connected to the grounding and bonding system of the building. The PCs are connected to the system via the PE contact of their power supply cable. The casing of the OSMs and the racks of the S7-300 PLCs are connected either directly or via a switching cubicle casing locally to the CBN. The shields of the twisted-pair cables interconnect all the device casings and are therefore connected to the grounding and bonding systems at both ends.

The horizontal power distribution within a floor corresponds to the requirements of a TN-S system. The neutral cable N and grounding conductor PE are separate cables. The PE grounding conductor does not contribute to the power supply of the devices. The parallel cable shields of the twisted-pair cables are therefore also free of neutral cable currents.

The vertical, inter-floor parallel distribution is designed as a TN-C system (common PEN cable for N and PE). The PEN is the return cable of the power supply of all connected consumers. A connection between the two OSMs at the bottom right-hand edge of the picture over shielded twisted-pair cables would allow the return cable current of the PEN to flow through the entire bonding system, all PE cables, and all cable shields on both floors. It is therefore strongly recommended to implement the inter-floor connection between the two OSMs with fiber-optic cables.

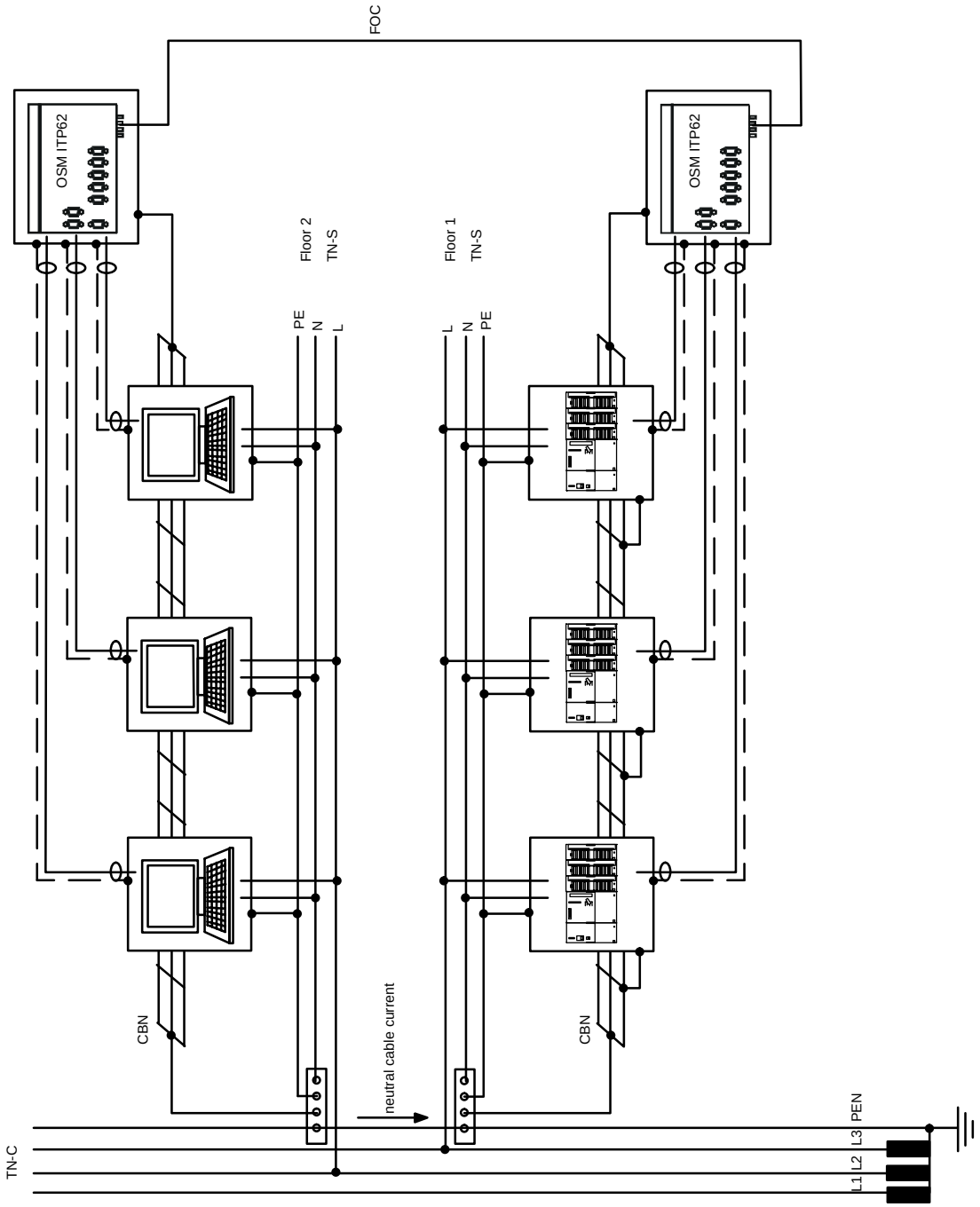


Figure 7-1 Fiber-Optic Cables Avoid Shield Currents in the TN-C-S network

7.3.4 Shielding Devices and Cables

Shielding Cables

The high degree of noise immunity of SIMATIC NET twisted pair copper networks is achieved by the exclusive use of shielded twisted-pair cables. The highly symmetrical twisted signal wires are surrounded by a combination of foil and braided mesh shields. The shield makes large-area, conductive contact with the casing of the attached DTE or network component at both ends of the twisted-pair cable via the connector/outlet. The entire communications electronics, consisting of transmitter and receiver chips as well as the signal cables is protected from electromagnetic influence from the outside world by a closed “cocoon” of electrically conductive device casing and cable shield.

Note

The values specified for noise emission and noise immunity in the technical specifications of all SIMATIC NET Industrial Ethernet components assumes the use of shielded twisted-pair cables.

As explained in the installation rules for the devices, the shields of the twisted-pair cables must make good conductive contact with the device casing at **both** ends. This is ensured by the SIMATIC NET connectors designed specially to match the devices.

If, on the other hand, the rules are ignored and unshielded cables are used or the shields do not make contact with the casing at both ends, there is no longer any guarantee that the technical data regarding noise emission and noise immunity will be adhered to. In this case, the operators of the system must take responsibility themselves for compliance with the legal limit values for noise emission and noise immunity (CE mark)!

Handling Bus Cable Shields

Note the following points about cable shields:

- Use SIMATIC NET twisted-pair cables throughout your system. The shields of these cables have an adequate density to meet the legal requirements regarding noise emission and immunity.
- Always contact the shields of bus cables at both ends. The legal requirements for noise emission and noise immunity in your system (CE marking) can only be achieved when the shields make contact at both ends.
- Secure the shield of the bus cable to the connector casing.
- If cables are installed permanently, it is advisable to remove the insulation of the shielded cable and to establish contact on the shield/PE conductor bar.

Note

If there is a potential difference between the grounding points, an illegally high compensating current can flow through the shield grounded at both ends. To rectify the problem, do not, under any circumstances, open the shield of the bus cable.

This problem can be solved in the following ways:

- Install an additional bonding conductor parallel to the bus cable that takes over the shield current (for notes on equipotential bonding refer to Section 7.3.2)
- Use fiber-optic cable instead of electrical cable (safest solution).

Establishing Shield Contact

When contacting the cable shields, please note the following points:

- Secure the braided shield with metal cable clamps.
- The clamps must make good and large-area contact with the shield (see Figure 7-2).
- Contact SIMATIC NET twisted-pair cables only using the braided copper shield and not the aluminum foil shield. The foil shield is connected to a plastic foil to increase tearing strength and is therefore non-conductive.
- Contact the shield with the shielding bar directly at the point at which the cable enters the cabinet.

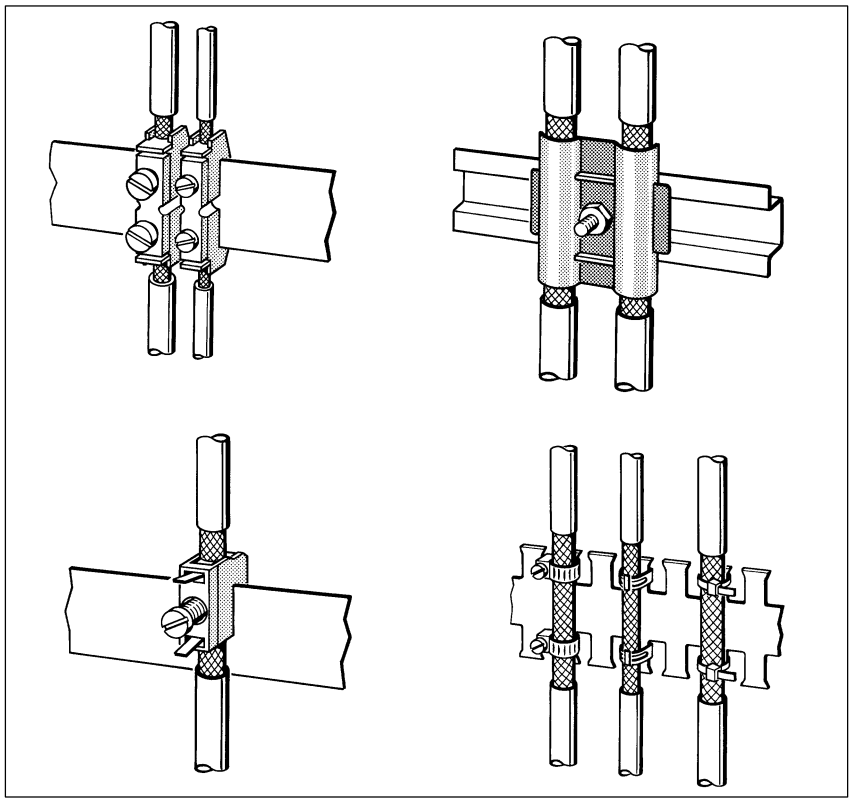


Figure 7-2 Securing Shielded Cables with Cable Clamps and Ties (schematic representation).

- When removing the sheath of the cable, make sure that the braid shield of the cables is not damaged.
- To allow good contact between grounding elements, tin-plated or galvanically stabilized surfaces are ideal. With galvanized surfaces, the necessary contact should be achieved using suitable screws. Painted surfaces should be avoided at the contact points.

- Unless specifically intended for this purpose, shield clamps and contacts should not be used for strain relief. The contact with the shielding bar could be impaired or be broken altogether.

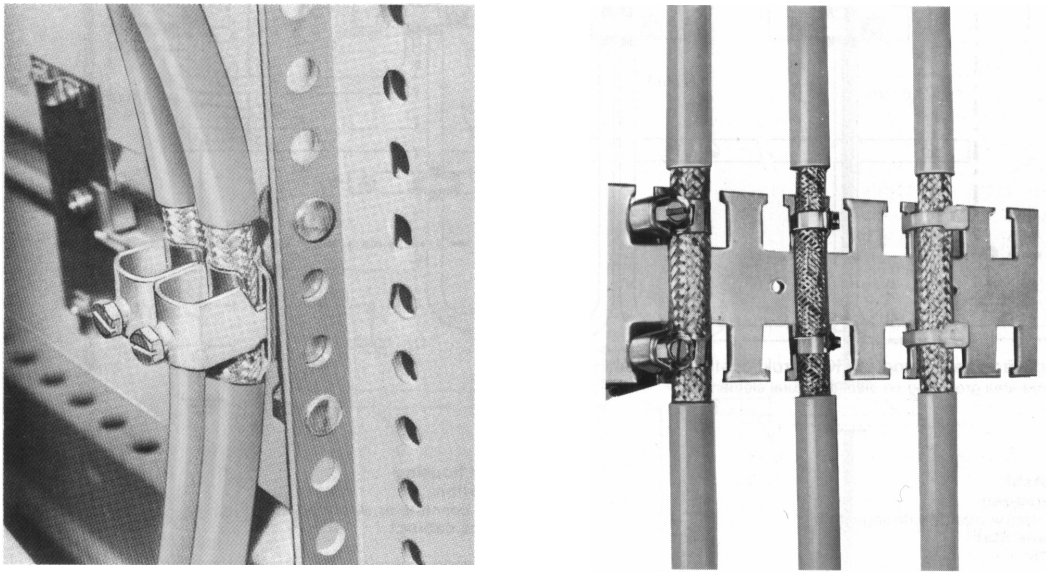


Figure 7-3 Contacting the Shield at the Point of Entry to a Closet

7.3.5 Special Noise Suppression Measures

Connecting Switched Inductances to Suppressors

Some inductive switching devices (for example relays) create interference voltages that are a multiple of the switched operating voltage. The distributed SIMATIC S7-300 /9/ and S7-400 /10/ system manuals contain suggestions about how to limit the interference voltages caused by inductance by connecting them to suppressors.

Power Supply for Programming Devices

It is advisable to include a power socket for programming devices in each cabinet. The socket must be supplied by the same system to which the PE conductor for the cabinet is connected.

Cabinet Lighting

Use bulbs for the cabinet lighting, for example LINESTRA® lamps. Avoid the use of fluorescent lamps since they cause interference. If you need to use fluorescent lamps, take the measures shown in Figure 7-4.

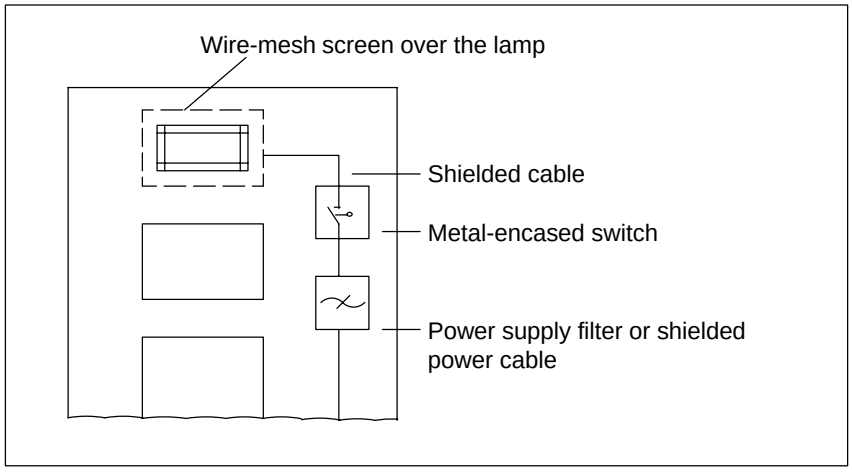


Figure 7-4 Measures for Interference Suppression of Fluorescent Lamps in a Cabinet

7.4 Arrangement of Devices and Cables

Adequate Clearance to Reduce the Effects of Interference

One simple but nevertheless effective method of reducing the effects of interference is to keep the “culprit” and “victim” devices and cables as far apart from each other as possible. Inductive and capacative interference injection declines in proportion to the square of the distance of the elements involved. This means that doubling the clearance reduces the effects of interference by a factor of four. Taking certain aspects into account during the planning phase of a building generally incurs little extra cost and can save considerable effort later.

Standards Recommending the Spatial Arrangement of Devices and Cables

EN 50174-2 /13/ includes recommendations on the spatial arrangement of devices and cables with the aim of achieving the lowest possible mutual interference.

7.4.1 The Influence of Power Distribution Systems (EN 50174-2, 6.4.4.2)

Planning the Electrical Installations

To avoid the power distribution system affecting sensitive devices, the following points must be taken into account when planning the electrical installation:

- Possible sources of interference, for example voltage distributors, voltage transformers, elevators, high currents in power supply bars, must be located at a suitable distance from sensitive devices:
- Metal pipes (for example for water, gas, heating) and cables should enter the building at the same point;
- The metal surfaces, shields, metal pipes, and connections of such conduits must be connected with low-resistance conductors to the main bonding conductor of the building.
- Using a common cable route for low-voltage cable and signal cables with adequate separation (either by clearance or shielding) between the two to avoid large induction loops that are created by the different low-voltage cabling.
- The use of either a single multi-core cable for all power supplies or (in the case of higher power requirements) of conductor bars with weak magnetic fields.

7.4.2 Cable Categories and Clearances

Fiber-Optic Cables

When using fiber-optic cables, mechanical protection is necessary, however the EMC rules do not apply.

Cable Groups

It is useful to group wires and cables into various categories according to the signals they carry, possible interference signals, and their sensitivity to interference. Minimum clearances can be specified for these categories so that interference-free operation can be expected under normal operating conditions if the clearance is adhered to.

Conditions

Grouping cables according to voltage classes assumes that the interference voltages relate directly to the power supply voltage conducted (the lower the supply voltage, the lower the interference voltage). Remember, however, that DC or 50 Hz power supply voltages do not represent any danger to Industrial Ethernet bus cables. The critical interference voltages in the kHz to MHz frequency range are created by the “consumer” connected to the cable. A 24 V DC cable with which a relay is switched regularly has a far more critical interference range than a 230 V cable supplying a light-bulb.

In the information shown below, it is assumed that all the components within an automation system and all the plant components controlled by the system (for example machines, robots etc.) at least meet the requirements of the European standards for electromagnetic compatibility in an industrial environment. If devices are defective or incorrectly installed, higher interference voltages must be expected!

The following is assumed:

- The cables for analog signals, data signals and process signals are always shielded.
- The distance from the cables to the chassis surface of the system (cabinet wall, grounded and conducting cable channel, ...) is not more than 10 cm.

Note

In general, the greater the distance between cables and the shorter the distances over which the cables run parallel to each other, the less the danger of interference.

How to Read the Table

To check how cables of different types must be laid, follow the steps outlined below:

1. Find the cable type of the first cable in column 1 (cables for ...).
2. Find the cable type of the second cable in the relevant section in column 2 (and cables for ...).
3. Read the guidelines for laying the cables in column 3 (lay ...).

Table 7-1 Cabling Within Buildings

Cables for ...	and cables for ...	lay ...
Bus signals, shielded (PROFIBUS, Industrial Ethernet) Bus signals, unshielded (AS-Interface)	Bus signals, shielded (PROFIBUS, Industrial Ethernet) Bus signals, unshielded (AS-Interface) Data signal, shielded (PG, OP, printer, counter inputs etc.) Analog signals, shielded DC voltage (= 60 V), unshielded Process signals (= 25 V), shielded AC voltage (= 25 V), unshielded Monitors (coaxial cable)	In common bundles or cable channels
	DC voltage (> 60 V and = 400 V), unshielded AC voltage (> 25 V and = 400 V), unshielded	In separate bundles or cable channels (no minimum clearance required)
	DC and AC voltage (> 400 V), unshielded	**Within closets:** In separate bundles or cable channels (no minimum clearance required) **Outside closets:** On separate cable paths with at least 10 cm clearance
	HF cables for transmitter high level stages and transmitter antennas with voltages from 10 to 1000 V	Lay HF cables in steel pipes with multiple ground points; at least 30 cm clearance

7.4.3 Cabling within Closets

When running cables within cubicles and cabinets, remember the following rules:

- Install the cables in metallic, electrically conductive cable channels.
- Screw the cable channels to the struts of the rack or cubicle walls approximately every 50 cm making low-resistance and low-inductance contact.
- Separate the cables according to the categories as shown in table 7-1 .
- Maintain the minimum clearance between the cables of different categories as explained in table 7-1 . In general, the risk of interference due to crosstalk is less the greater the clearance between the cables.
- Where cables of different categories cross, they should cross approximately at right angles (wherever possible avoid sections where the cables run parallel).
- The shields of all cables entering the wiring closet should make large-area contact with closet ground as close as possible to the point of entry.

7.4.4 Cabling within Buildings

When laying cables outside cabinets but within buildings, note the following points:

- Lay the cables in metallic, electrically conducting cable channels.
- Include the metal cable channels and racks in the bonding system of the building or plant. Note the information on equipotential bonding in Section 7.3 in this manual.
- Separate the cables according to the categories as described in table 7-1 and run the various categories in their own channels/racks.
- If there is only one common metal channel available for all categories, either the clearances shown in Table 7-1 must be maintained or the individual categories should be separated from each other by metallic partitions. The partitions must be connected to the channel making low-resistance and low-inductance contact.
- Cable racks should cross each other at right angles.

7.4.5 Cabling outside Buildings

Using Fiber-Optic Cables

Industrial Twisted Pair is intended for use within buildings (tertiary area). The installation of Industrial Twisted Pair cables between buildings in not permitted. LAN connections between buildings and between buildings and external facilities are only possible with fiber-optic cables (FO). Due to the optical transmission principle, fiber-optic cables are not affected by electromagnetic interference. Measures for equipotential bonding and overvoltage protection are unnecessary with fiber-optic cables.

7.5 Mechanical Protection of Bus Cables

Protection of Electrical and Optical Bus Cables

Mechanical protection is required to protect bus cables from breaks or mechanical damage.

Note

The guidelines for mechanical protection apply both to electrical and optical cables.

Measures for Mechanical Protection

The following measures are recommended to protect bus cables from physical damage:

- When cable cannot be installed on a cable rack or similar construction, it should be installed in a conduit (for example PG 11-16).
- In areas where the cable is subject to mechanical stress, install the cable in a heavy-gauge aluminum conduit or in a heavy-gauge plastic conduit (see Figure 7-5)
- When 90° bends are necessary and at the junctions between buildings (for example expansion joints), a break in the conduit is acceptable only when there is no likelihood of damage to the cable, for example due to falling objects (see Figure 7-6).
- In areas where the cable is likely to be walked on or driven over, the cable must be protected from damage by a closed heavy-gauge aluminum or steel conduit. As an alternative, the cable can be laid in a metal cable gutter.

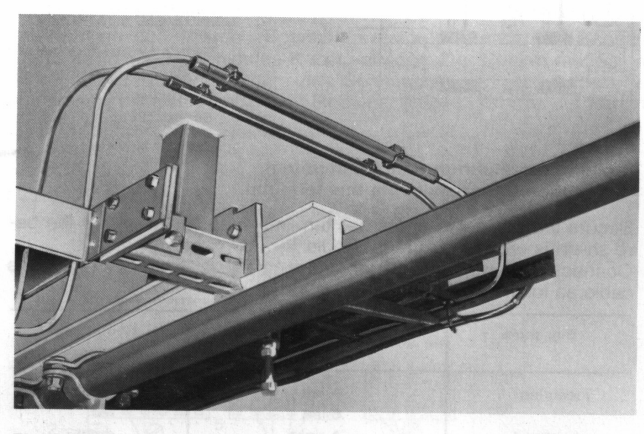


Figure 7-5 Mechanical Protection of the Bus Cable

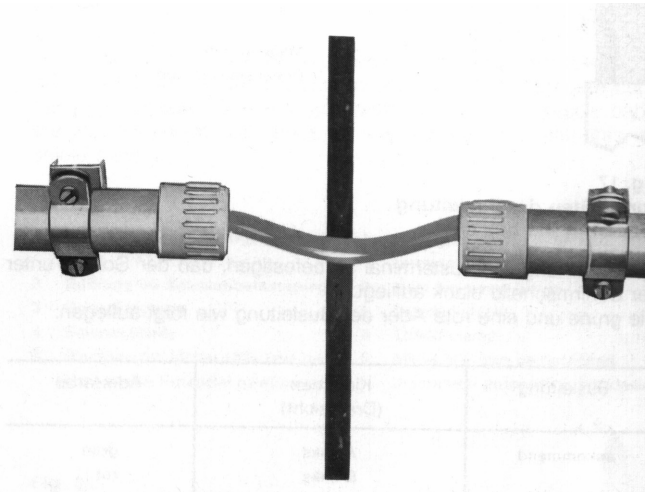


Figure 7-6 Interrupting the Conduit at an Expansion Joint

Redundant Bus Cables

The installation of redundant bus cables involves special requirements. Redundant cables should always be installed on separate cable racks to avoid simultaneous damage by the same event.

Install Bus Cables Separately

To prevent accidental damage to bus cables, they should be clearly visible and should be separate from all other wiring and cables. To improve EMC, it is often advisable to install the bus cables in a separate cable channel or in conductive, metal tubes. Such measures also make it easier to localize a faulty cable.

7.6 Electromagnetic Compatibility of Fiber-Optic Cables

Fiber-Optic Cables

For communications between buildings and/or external facilities, the use of fiber-optic cables is generally recommended. Due to the optical transmission principle, fiber-optic cables are not affected by electromagnetic interference. Measures for equipotential bonding and for overvoltage protection are unnecessary with fiber-optic cables.

Note

Fiber-optic cables are ideally suited for LAN connections in areas with high EMI levels. Remember, however, that bus components operating on an electrical basis such as OLMs, OSMs/ORMs etc. may require additional noise protection measures if they are being operated in such areas. These must be protected using the measures already mentioned such as shielding, grounding, minimum clearance to sources of interference etc.

7.7 Installing LAN Cables

7.7.1 Instructions for Installing Electrical and Optical LAN Cables

General

During installation, remember that LAN cables can only be subjected to a certain amount of mechanical strain. Cables can be damaged or even destroyed by too much tensile stress or pressure, by torsion or by bending them too sharply. The following instructions will help you to avoid damage when installing LAN cables.

If cables are subjected to strain or stress as listed above, they should always be replaced.

Storage and Transportation

During storage, transportation and cabling, the open ends of the LAN cable (without connectors) must be kept closed with a shrink-on cover to prevent oxidation of the cores and to keep dampness out of the cable.

Temperatures

During transportation, cabling and operation, the cable must not be exposed to temperatures below the specified minimum temperature or above the specified maximum temperature otherwise the electrical and mechanical characteristics of the cables can deteriorate. The permitted temperature ranges of your LAN cable can be found in the technical data sheets of the LAN cables in Chapters 4 and 5.

Tensile Strength

The tensile force exerted on the cables during or after installation must not exceed the limits of tensile strength of the cables. The permitted tensile strain on your LAN cable can be found in the technical data sheets of the bus cables in Chapters 4 and 5.

Pull Preassembled Cables Using Cable Grips

To pull preassembled cables, make sure that you use cable grips. These surround the connector and protect it from damage when pulling in the cable.

Fitting strain relief

Make sure that you provide strain relief approximately 1 m from the connection point on all cables subject to tensile force. Shield clamps are not adequate for strain relief.

Pressure

Too much pressure on the cables must also be avoided, for example crimping the cable when securing it in position.

Torsion

Torsion can lead to the elements of a cable being displaced and degrading the electrical characteristics of cables. LAN cables must not be twisted.

Bending Radius

To avoid damage within the LAN cables, they must at no time be bent more sharply than the minimum bending radius. Note that the permitted bending radii

- are larger when pulling in the cable under tensile strain than in the fixed, installed state
- Bending radii for non-circular cables apply only to bending the flat, broader surface. Bends in the narrower surface require much greater radii.

The permitted bending radii for your LAN cable can be found in the technical data sheets of the LAN cables in Chapter 4 and 5.

Avoid Loops

When laying LAN cables, roll them tangentially from the cable drum or use appropriate rotary tables. This prevents loops forming and resulting in kinks and torsion.

Installing other Cables

Remember that cables must not be subjected to excessive strain and stress when installed. This can, for example, happen when cables are installed along with other cables on a common rack or in a common duct (providing this is electrically permitted) and when new cables are pulled along the same path later (during repairs or when extending a system).

7.8 Additional Instructions on Installing Fiber-Optic Cables

Protecting Connectors from Contamination

Fiber-optic cable connectors are sensitive to contamination. Unconnected male and female connectors must be protected with the supplied dust caps.

Attenuation Variations under Load

During installation, fiber-optic cables must not be twisted, stretched or squashed. The specified limit values for tensile strain, bending radii and temperature ranges must be adhered to. During installation, the attenuation values can vary slightly, these variations are, however, reversible providing the strain limits are not exceeded.

Pull Cables Using Cable Grips and Protect Connectors

If the cable does not have a Kevlar pulling attachment, make sure that you use cable grips. Before fitting the cable grip, make sure that the connectors of preassembled cables are protected from the pressure exerted by the cable grip, for example using a piece of protective tube.

Fitting Strain Relief

Although the BFOC connectors have their own strain relief and kink protection, it is advisable to arrange for additional strain relief as close as possible to the connected device to protect against mechanical strain.

Plan Adequate Attenuation Reserves

When installing cables over greater distances, it is advisable to take into account one or more repair splices in the power loss budget.

Electromagnetic Immunity

Fiber-optic cables are immune to electromagnetic interference. Installing cables in cable channels along with other cables (for example 230 V/380 V power supply cables) causes no problems. When installing in cable channels, however, make sure that the permitted strain on the fiber-optic cables is not exceeded when pulling in other cables later.

7.9 Fitting Twisted Pair Connectors

General

To maintain the excellent EMC and transmission characteristics of the twisted-pair cabling system, connectors must be fitted with extreme care following the installation instructions exactly.

How to fit 9-pin and 15-pin connectors is explained in detail on the following pages.

Note

Fit the sub-D connectors only to the 2x2 Industrial Twisted-Pair standard cable. The cable clamp used for contacting the shield is designed for the diameter of this cable.

These sub-D connectors are not suitable for fitting to Industrial Ethernet FC cables.

9-Pin Sub-D Connector

Figure 7-7 shows all the components of a 9-Pin sub-D connector

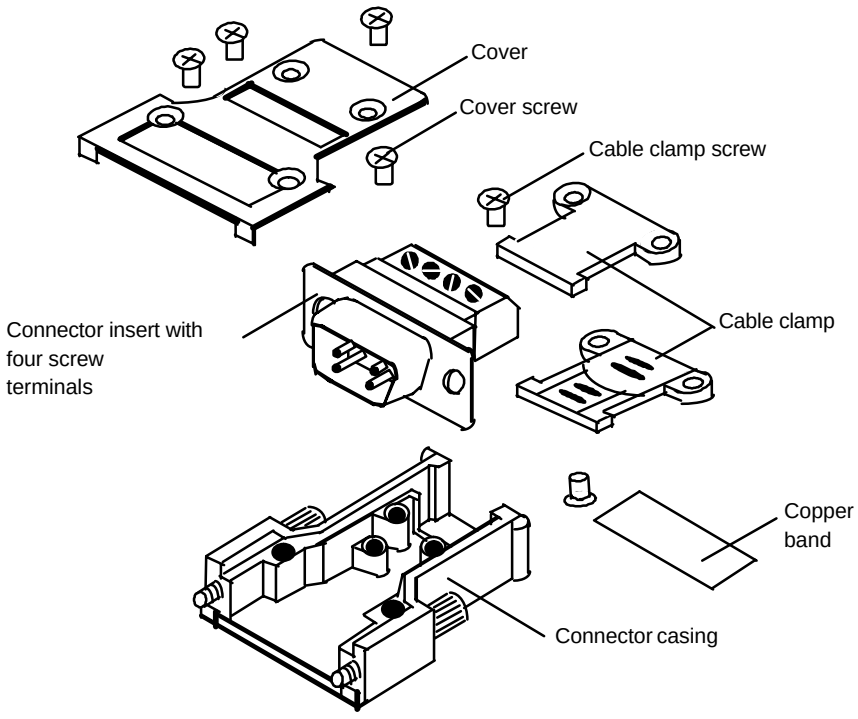
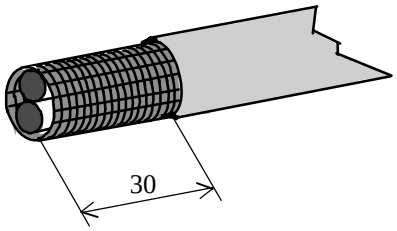


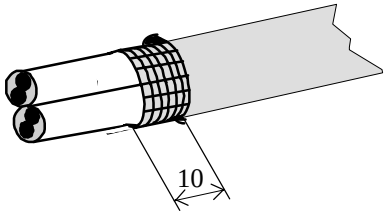
Figure 7-7 Industrial Twisted Pair Sub-D Connector (9-pin) for Assembly on Site

Fitting the Connector

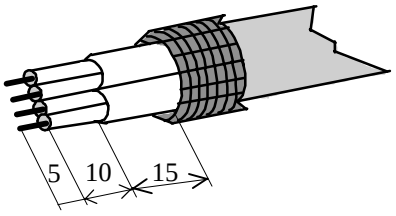
1. Remove approximately 30 mm of the outer sheath from the braided shield.



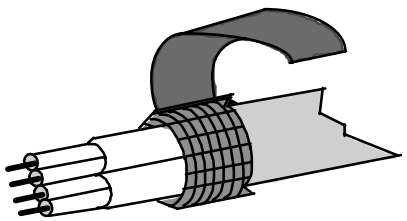
2. Cut the braided shield approximately 10 mm from the edge of the outer sheath and
   pull off the loose shield.



3. Turn back the braided shield over the outer sheath.
   - Unwind the aluminum foil shield up to a point approximately 15 mm from the folded back braided shield and cut off the unwound material.
   - Remove the plastic foil and blind elements.
   - Remove approximately 5 mm of the insulation from the conductors.



4. Wrap copper band around the braided shield



5. Fit the connector
   - Fit the connector insert into the connector casing
   - Fit the lower cable clamp into the grooves of the connector casing
   - Assign the wire pairs to the screw terminals.
     You will find the assignment required for a particular cable type in section LEERER MERKER “Preassembled Industrial Twisted-Pair Cables”.
   - Fit the cable into the connector casing so that the braided shield with the copper band lies in the cable clamp
   - Fit the upper cable clamp into the grooves of the connector casing and screw it tight
   - Secure the conductors in the screw terminals
   - Screw the cover on to the connector casing

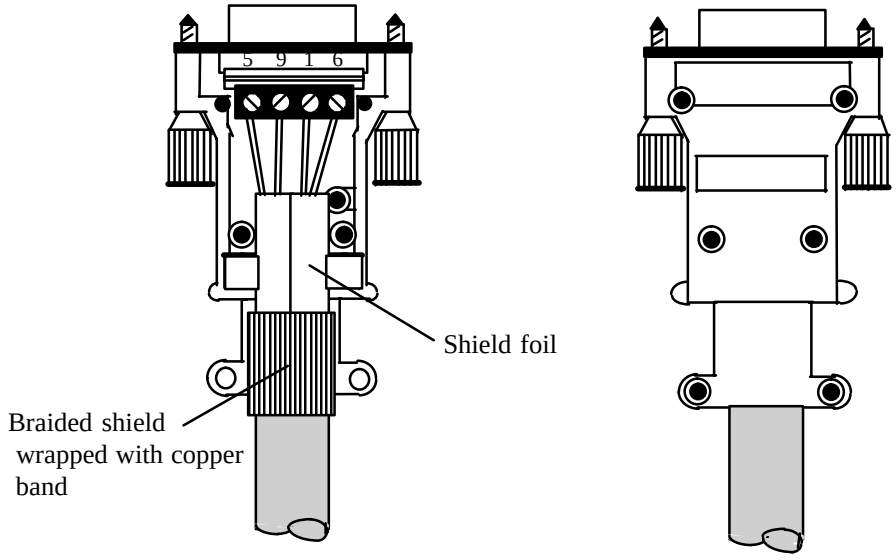


Figure 7-8 9-Pin Sub-D Male Connector Fitted to the Standard Cable

15-Pin Sub-D Connector

Figure 7-9 shows all the components of a 15-pin sub-D connector

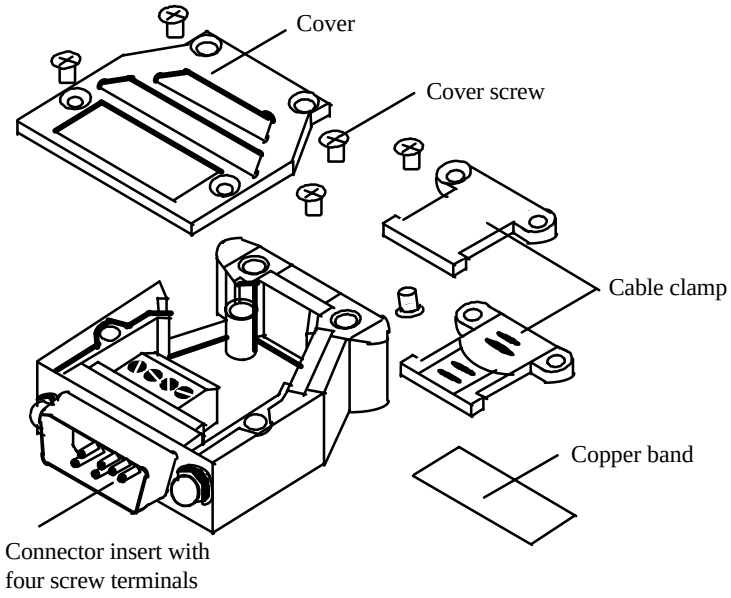
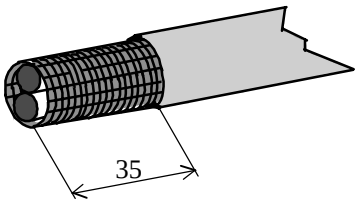


Figure 7-9 15-Pin Sub-D Connector for User Assembly

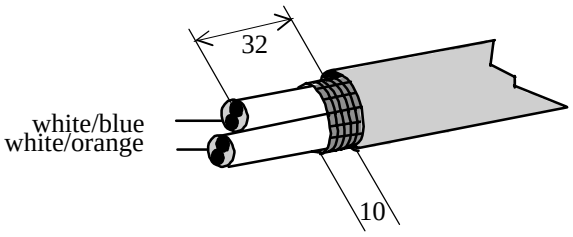
Fitting Connectors

1. Remove approximately 35 mm of the outer sheath from the braided screen.

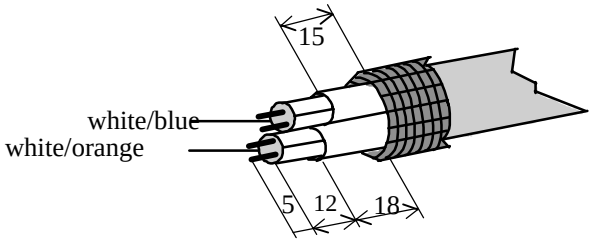


2. Cut the braided shield approximately 10 mm from the edge of the outer sheath and
   pull off the loose shield.

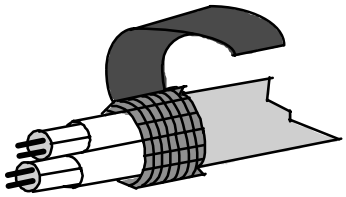
   Shorten the white-blue pair by approximately 3 mm to 32 mm
   (to introduce the cable as shown in Figure 7-10).



3. - Fold back the braided shield over the outer sheath.
   - Unwind the aluminum foil shield leaving approximately 15 mm (shorter pair) or approximately 18 mm (longer pair) to the folded back braided shield and cut off the unwound shield.
   - Remove the plastic foil and blind element.
   - Remove approximately 5 mm of the insulation from the conductors.



4. Wrap copper band around the braided shield



5. Fit the connector
   - Fit the lower cable clamp into the grooves of the connector casing.
   - Fit the cable into the connector casing so that the braided shield with the copper band lies in the cable clamp
   - Fit the upper cable clamp into the grooves of the connector casing and screw it tight
   - Assign pairs of wires to the screw terminals
     You will find the assignment necessary for a particular cable type in Section LEERER MERKER “Preassembled Industrial Twisted Pair Cables”.
   - Secure the conductors in the screw terminals
   - Screw the cover on to the connector casing

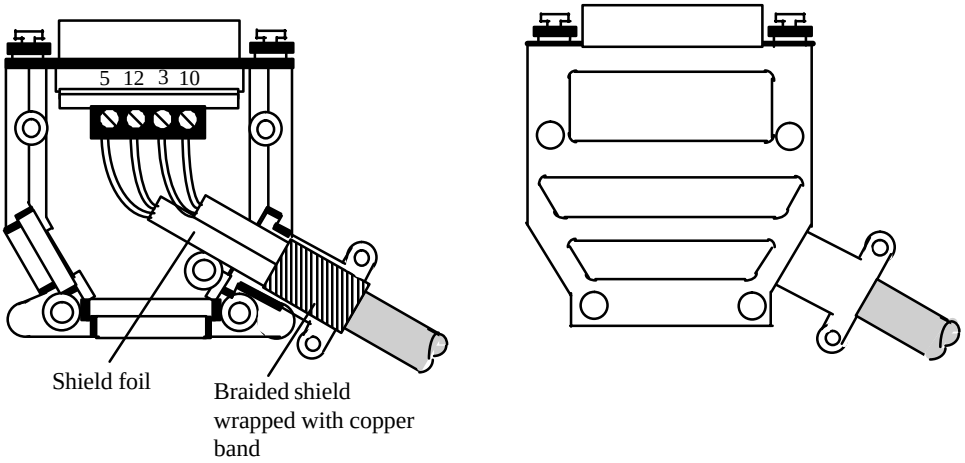


Figure 7-10 15-Pin Sub-D Male Connector Fitted to the Standard Cable

7.10 Installing and Wiring up the FC Outlet RJ-45

Components of the Industrial Ethernet FastConnect System

With the Industrial Ethernet FastConnect System, you can greatly reduce the time required for installation and the sources of error during installation of LAN cabling. The FC system consists of three components:

- IE FC Outlet RJ-45 with RJ-45 LAN jack and piercing terminal contacts for connecting the RJ-45 connector technology with the FC cable in an industrial environment
- Cat5 Plus certified fast installation cables with copper cores (IE TP FC Standard Cable, IE TP FC Trailing Cable and IE TP FC Marine Cable)
- IE FC Stripping Tool, the preset stripping tool.

These three components are ideally matched and allow an FC installation cable to be assembled within approximately two minutes.

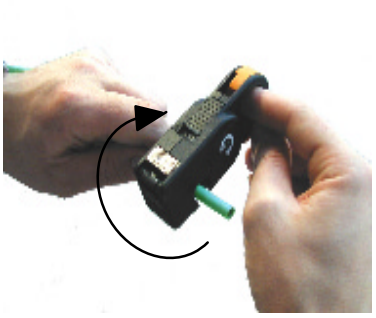
DTEs or network components can be connected to the FC Outlet RJ-45 in a wiring cubicle or in a control room using preassembled patch cables with RJ-45 connectors.

Stripping the IE FC Cable with the IE FC Stripping Tool

Measure the length to be stripped by holding the cable against the template. Mark the position using the index finger of your left hand.

Insert the measured end of the cable into the tool
as far as allowed by the index finger of the left hand.

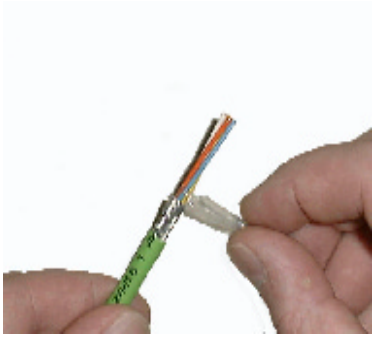
Clamp the end of the cable in the stripping tool.



Turn the stripping tool several times in the direction of the arrow to strip the cable.

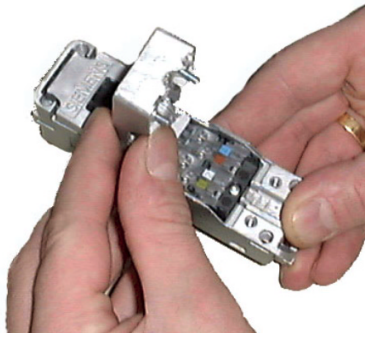
Keeping the tool closed, remove it from the end of the cable.

Connecting the Prepared FC Cable to the IE FC Outlet RJ-45

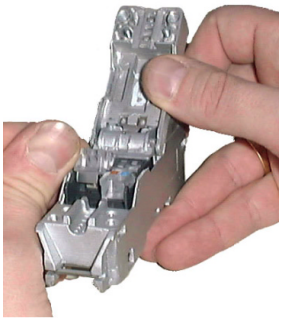


Remove the protective foil from the wires and the support element from between the wires.

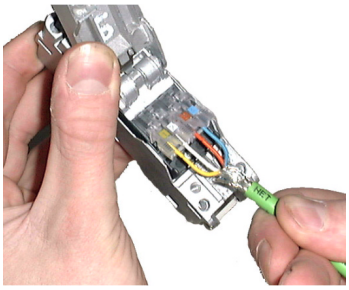
Spread out the wires according to the color code shown on the contact cover of the FC Outlet RJ-45.



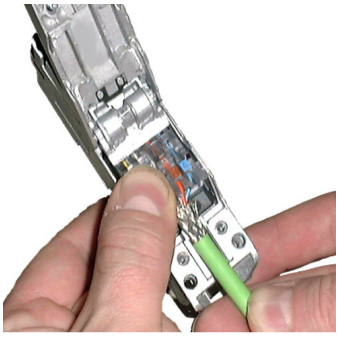
Open the cover of FC Outlet RJ-45.



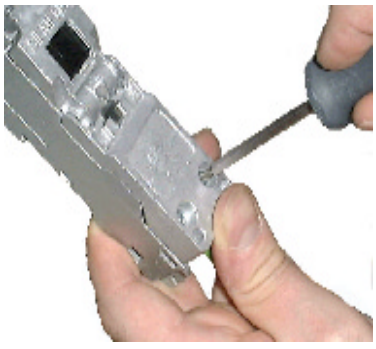
Open both contact covers.



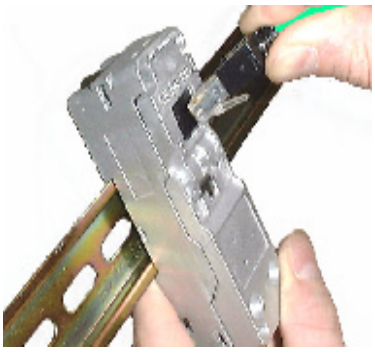
Insert the wires of the IE FC cable fully into the contact cover according to the color code.



Press down the two contact covers to contact the wires.



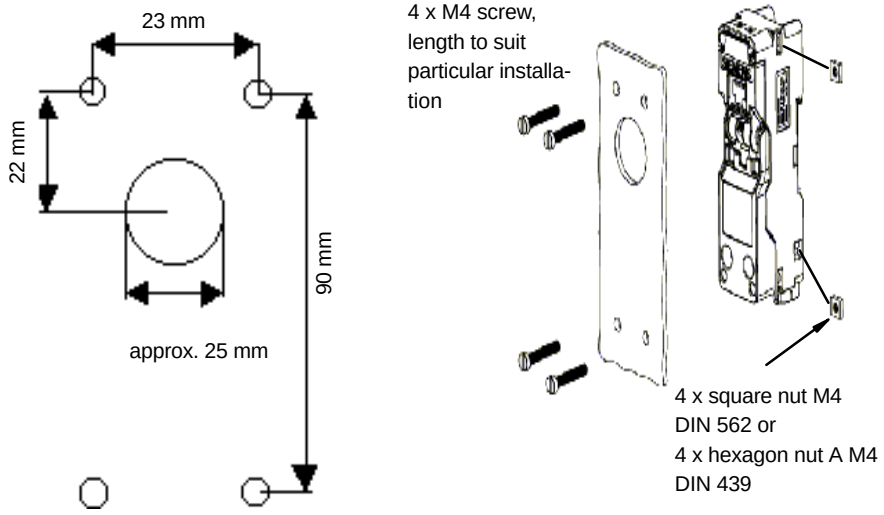
Close and screw down the outer cover of the FC Outlet RJ-45.



Connect the DTE or network component using a suitable RJ-45 patch cable.

Installing the IE FC Outlet RJ-45

The FC Outlet RJ-45 can be installed on a rail or screwed to a mounting surface. The Outlet RJ-45 can also be installed as a PG socket behind a wiring cubicle wall. If this is required, nuts must be fitted in the openings on the sides.


23 mm
22 mm
90 mm
approx. 25 mm
4 x M4 screw, length to suit particular installa-tion
4 x square nut M4 DIN 562 or 4 x hexagon nut A M4 DIN 439

Pin Assignment of the FC Outlet RJ-45

The assignment between the contacts of the RJ-45 jack and the insulation piercing terminals for the FC TP cable is as follows:

RJ-45 Pin Number	Insulation Piercing Terminals	
	Number	Wire Color
1	1	yellow
2	3	orange
3	2	white
6	4	blue

Note

The FC TP cable between two FC Outlet RJ-45 devices must always 1:1. In other words, terminal 1 must be connected terminal 1, terminal 2 to terminal 2 etc. If crossovers are required, this should always be done with one of the patch cables connected to the RJ-45 jack.

7.11 Connecting Fiber-Optic Cables

BFOC Connectors

Industrial Ethernet fiber-optic network components use only glass fiber-optic cables with BFOC connectors.

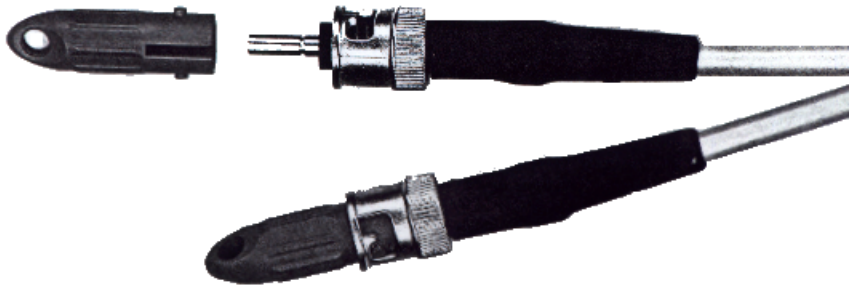


Figure 7-11 BFOC Connectors with Dust Caps

Note

Connectors should only be fitted to glass fiber-optic cables by trained personnel. When fitted correctly, they allow extremely low coupling attenuation and the value can be repeated after inserting the connector several times.

Preassembled Cables

To be able to use glass fiber-optic cables with untrained personnel, glass fiber-optic cables are also available with four BFOC connectors already fitted.

For ordering data, please refer to the current SIMATIC NET Catalog IK PI.

Fitting Connectors on Site

If it is necessary to fit connectors on site,
- BFOC connectors and suitable tools can be ordered (see IK PI)
- SIEMENS provides this service.

You can obtain further information from your Siemens contact in your local Siemens office.
You will find the addresses:
– in our Catalog IK PI
– on the Internet (http//www.ad.siemens.de)

Caution

Fiber-optic cable connectors are susceptible to contamination and mechanical damage. Protect open connections with the supplied dust caps. Only remove the dust cap immediately before making the connection.

Installing Network Components in Cubicles

8

Chapter Overview

8.1 IP Degrees of Protection 8-2

8.2 SIMATIC NET Components 8-4

8.1 IP Degrees of Protection

General

Electrical equipment is normally surrounded by a protective casing.

The purpose of this casing includes

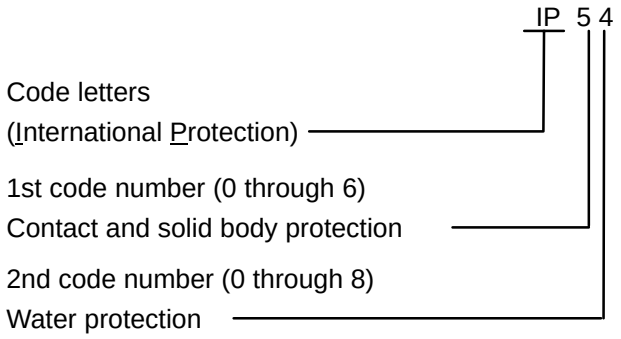
- Protection of persons from touching live components or moving parts (accidental contact protection)
- Protection of equipment from intrusion of solid foreign bodies (solid body protection)
- Protection of equipment from ingress of water (water protection).

IEC 60529, EN 60529 /15/

The degree of protection specifies the degree to which the casing meets these three protective functions.

The degrees of protection are specified uniformly in the “International Standard IEC 60529” or in the identical European standard EN 60529.

The degree of protection of a casing is indicated by a code. The code consists of the letters IP (International Protection) followed by a code number for contact, solid body and water protection as shown below:



In some situations, the degree of protection is specified in even greater detail by adding letters to the code numbers.

Degree of Protection

The various degrees of protection are listed briefly in Tables 8-1 and 8-2. For more detailed information on the individual ratings and the test conditions that must be fulfilled, please refer to the standards listed above.

Table 8-1 Contact Protection (short form)

First Number	Protection of equipment from intrusion of solid foreign bodies	Protection of people from access to dangerous parts
0	not protected	not protected
1	≥ 50.0 mm diameter	back of hand
2	≥ 12.5 mm diameter	finger
3	≥ 2.5 mm diameter	tool
4	≥ 1.0 mm diameter	wire
5	dust protected	wire
6	dustproof	wire

Table 8-2 Water Protection (short form)

Second Number	Protection of equipment from ingress of water
0	not protected
1	vertically falling drops of water
2	falling water (15° from vertical)
3	sprayed water
4	splashwater
5	jet water
6	strong jet water
7	temporary immersion
8	long period of immersion

8.2 SIMATIC NET Components

Ventilation Openings

The casings of most SIMATIC NET network components have ventilation openings. To allow more effective cooling of the electronics components, ambient air can flow through the casing. The maximum operating temperatures quoted in the technical specifications apply only when there is unrestricted flow of air through the ventilation openings.

Depending on the size of the ventilation openings, such modules comply with degree of protection IP 20, IP 30 to IP 40. You will find the precise degree of protection of a SIMATIC NET component in its operating instructions.

Components with the degrees of protection mentioned above do not provide protection against dust and water! If the installation site requires such protection, the components must be installed in an additional enclosure such as a switching cubicle that provides the higher degree of protection (for example IP 65/ IP 67).

If you install these components in an additional enclosure, make sure that the conditions required for operation are maintained!

Heat Dissipation

Make sure that the temperature inside the additional enclosure does not exceed the permitted ambient temperature for the installed components. Select an enclosure with adequate dimensions or use heat exchangers.

Outdoor Installation

If you install the equipment outdoors, make sure that the additional enclosure is not subjected to direct sunlight. This can lead to a considerable rise in temperature within the enclosure.

Clearances

Make sure that there is adequate clearance around the component so that

- the convection cooling of the component is not restricted
- components do not cause neighboring components to heat up more than permitted
- there is enough space for installing cabling
- there is enough space to remove components for maintenance or repair.

Note

Regardless of the degree of protection of the casing, the electrical and optical ports are always sensitive to

– mechanical damage

– damage caused by electrostatic contact discharge

– contamination by dust and fluids

Close unused ports with the supplied dust protection caps. Remove these caps only immediately before connecting up the cables to the ports.

Standards

EN 60529:2000 degree of protection due to casing (IP Code) (IEC 60529:1999)

Further Literature

Klingberg, G.; Mähling, W.: Schaltschrank– und Gehäuse–Klimatisierung in der Praxis (mit EMV); Heidelberg 1998

Dimension Drawings

9

Chapter Overview

9.1	Optical Link Module (OLM) and Electrical Link Module (ELM)	9-2
9.2	Optical Switch Module (OSM)	9-3
9.3	Electrical Switch Module ESM	9-6
9.4	ASGE Active Star Coupler	9-9
9.5	MINI OTDE Optical Transceiver	9-10
9.6	MINI UTDE RJ-45 Electrical Transceiver for Industrial Ethernet	9-10
9.7	Connectors	9-11
9.8	Front View of the IE FC Outlet RJ-45	9-14
9.9	Side View of the IE FC Outlet RJ-45	9-15

9.1 Optical Link Module (OLM) and Electrical Link Module (ELM)

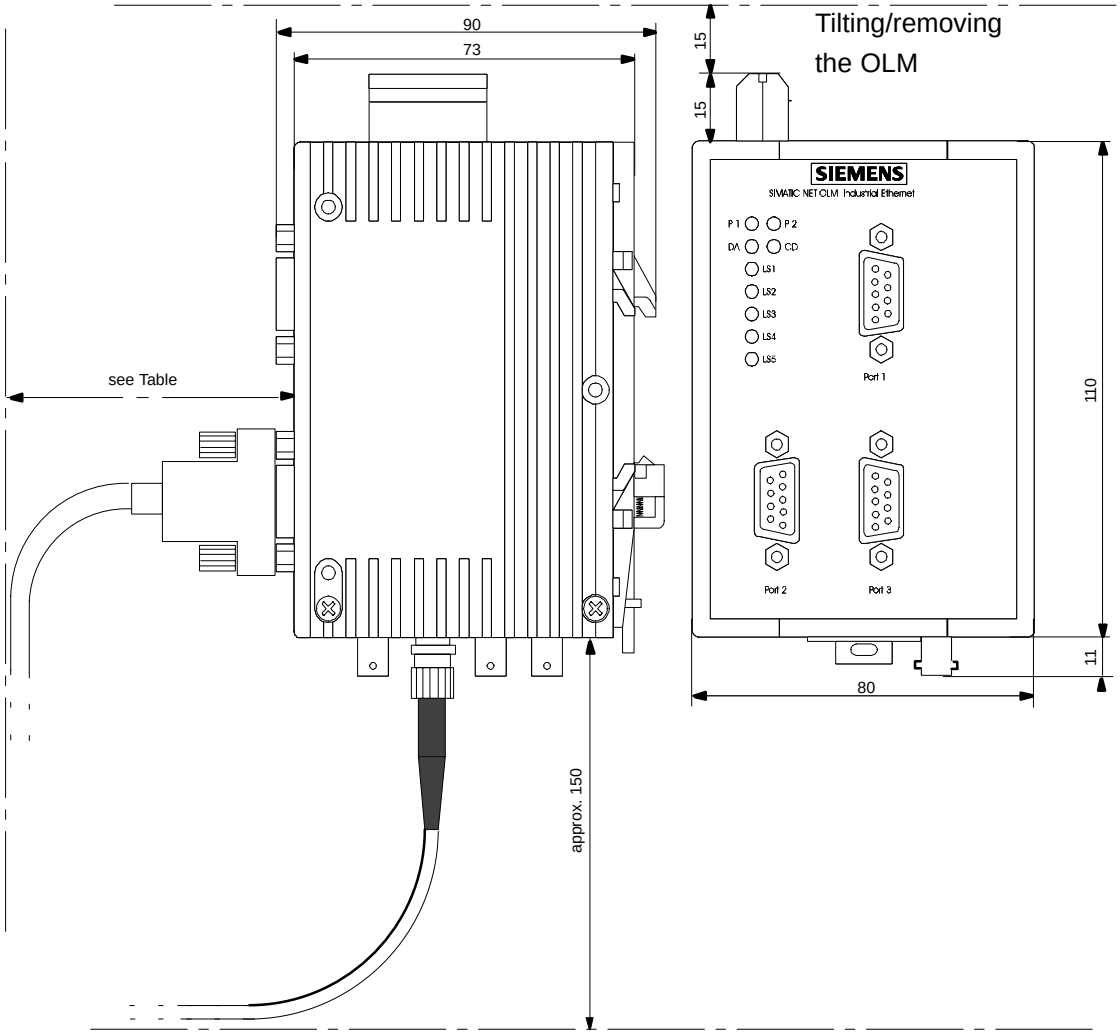


Figure 9-1 Industrial Ethernet OLM/ELM (dimensions in mm)

Cable Type	Space Required
9-pin sub-D connector for user assembly on ITP standard cable	approx. 160 mm
Preassembled Cables	
ITP standard cable 9/x	approx. 95 mm
ITP XP standard cable 9/x	approx. 95 mm
Preassembled Cables	
TP Cord 9/x (horizontal cable outlet)	approx. 95 mm
ITP Cord 9/x (horizontal cable outlet)	approx. 95 mm

9.2 Optical Switch Module (OSM)

Outer Dimensions and Clearances Required for Installation of the OSM ITP62, OSM ITP62-LD, ITP53

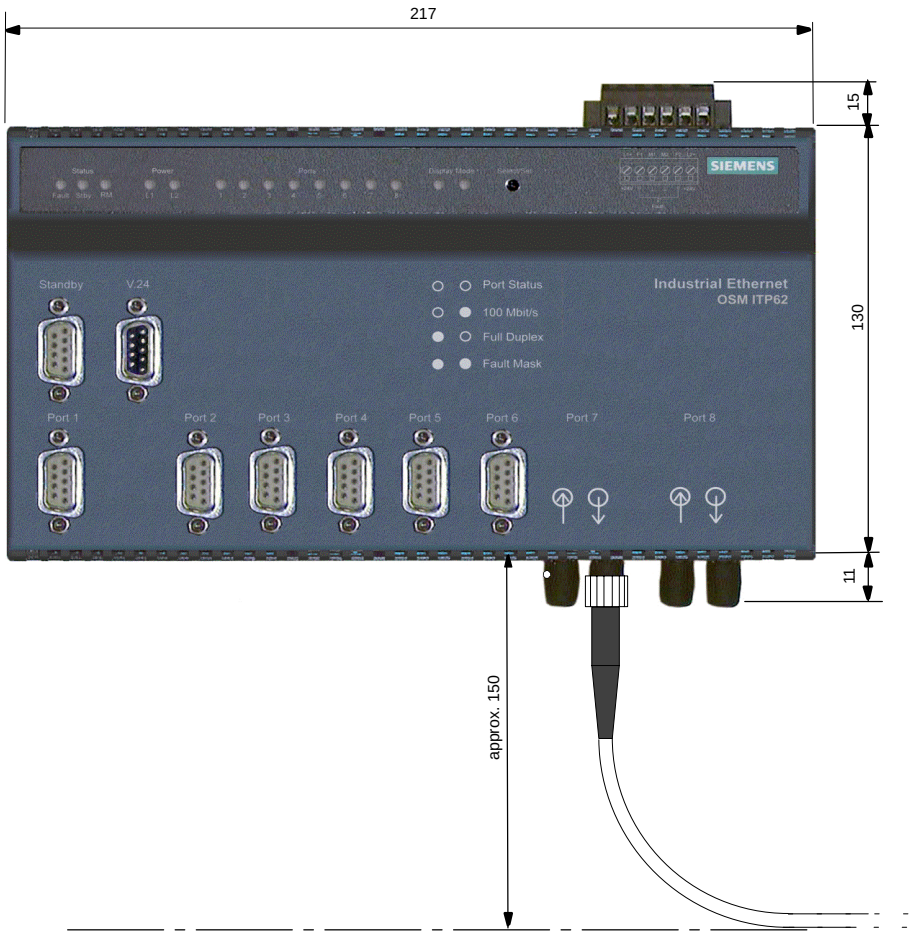


Figure 9-2 Industrial Ethernet OSM ITPxx (dimensions in mm)

Outer Dimensions and Clearance Required for Installation of the OSM TP62

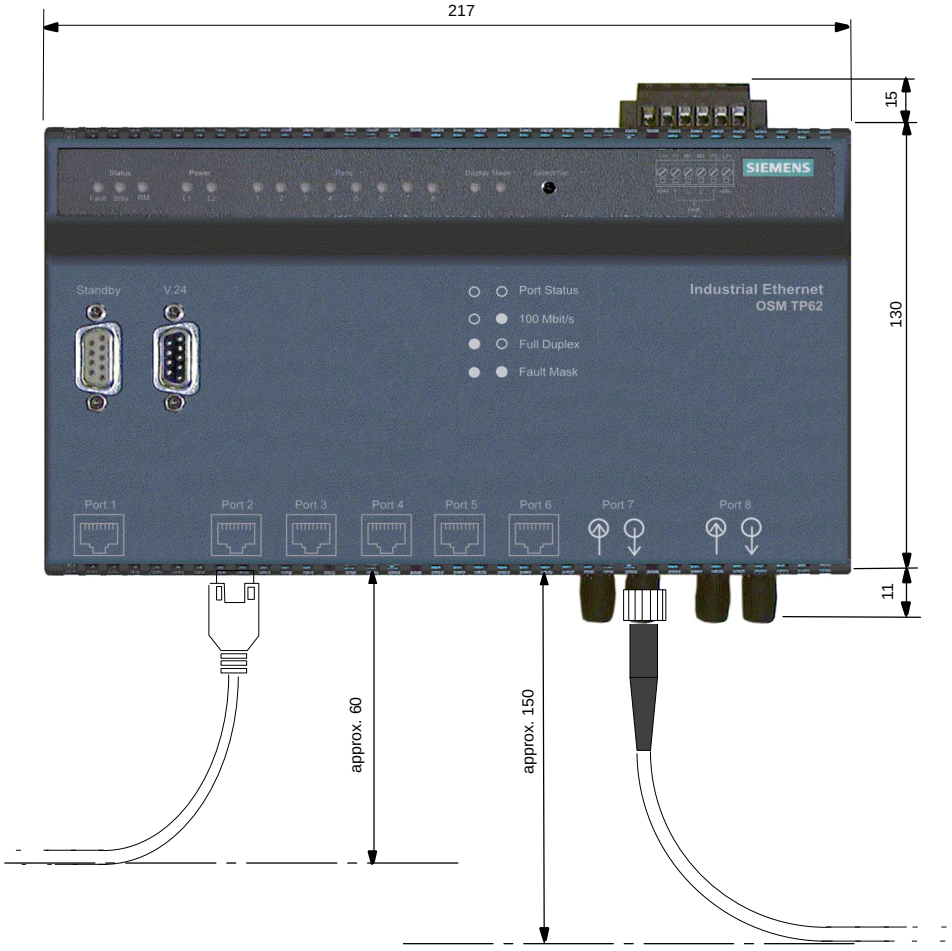


Figure 9-3 Industrial Ethernet OSM TPxx (dimensions in mm)

Side View of the OSM

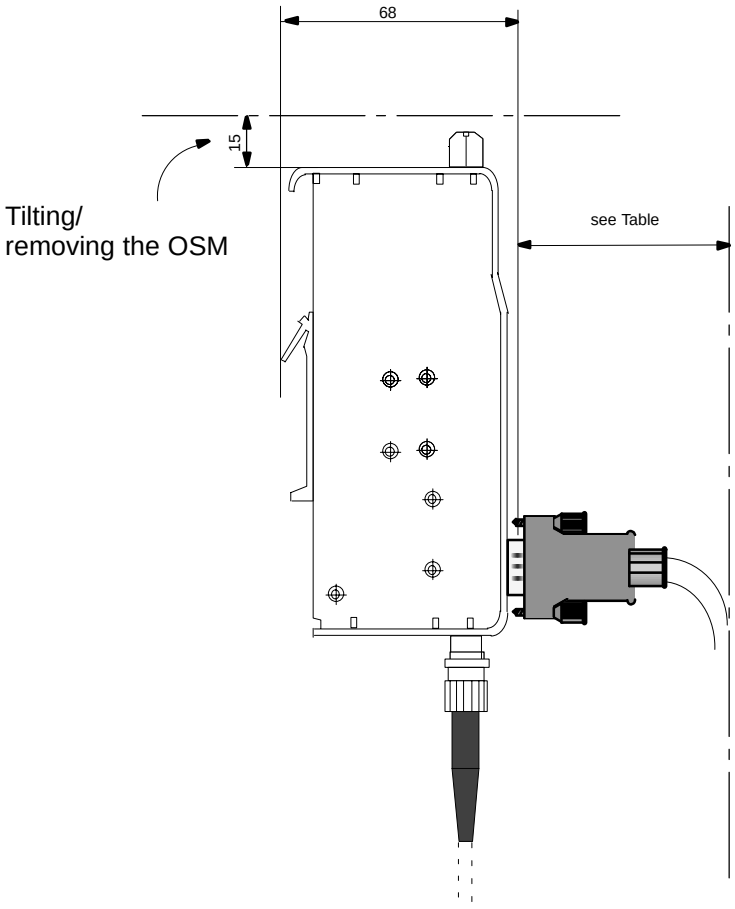


Figure 9-4 Industrial Ethernet OSM (side view; dimensions in mm)

Cable Type	Space Required[1)]
9-pin sub-D connector for user assembly on ITP standard cable	approx. 160 mm
Preassembled Cables ITP standard cable 9/x ITP XP standard cable 9/x	 approx. 95 mm approx. 95 mm
Preassembled Cables TP Cord 9/x (horizontal cable outlet) ITP Cord 9/x (horizontal cable outlet)	 approx. 95 mm approx. 95 mm
TP Cord 9-45/x (45° cable outlet) TP XP Cord 9-45/x (45° cable outlet)	approx. 65 mm approx. 65 mm

1) for TP port and Standby-Sync port

9.3 Electrical Switch ModuleESM

Outer Dimensions of the ESM ITP80

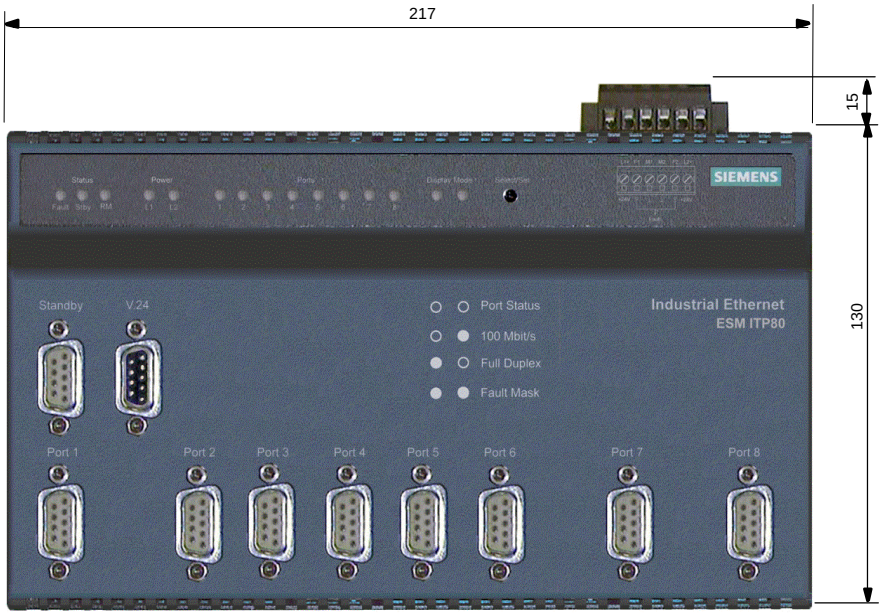


Figure 9-5 Industrial Ethernet ESM ITP80 (dimensions in mm)

Outer Dimensions of the ESM TP80

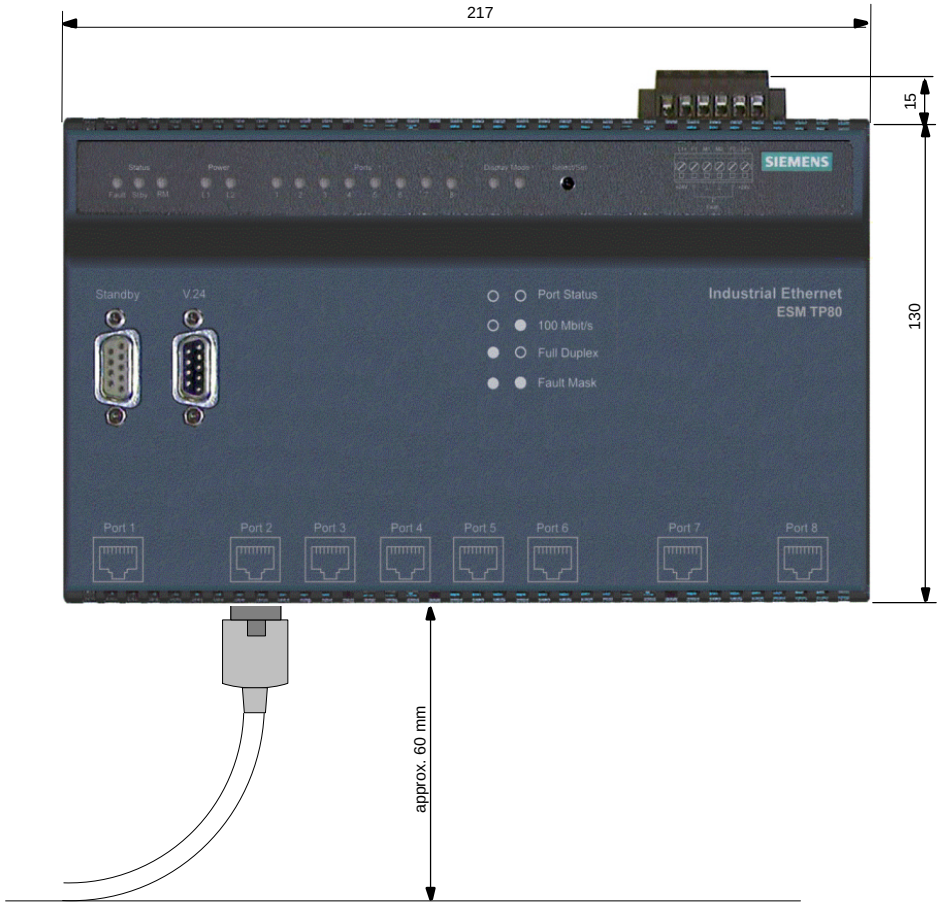


Figure 9-6 Industrial Ethernet ESM TP80 (dimensions in mm)

Outer Dimensions and Clearance Required for Installing the ESM ITP80/TP80 (side view)

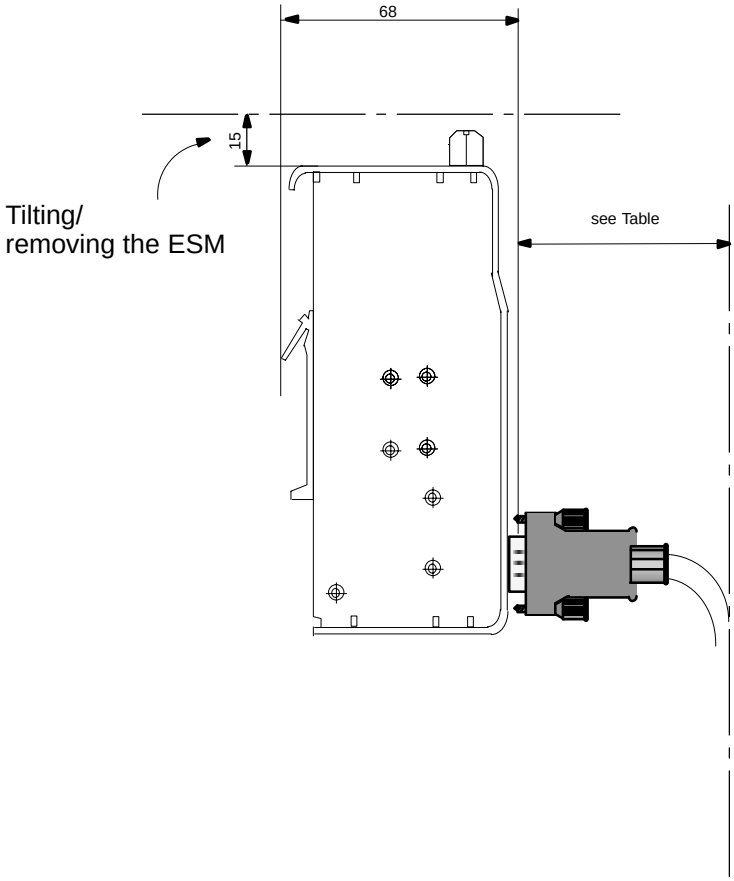


Figure 9-7 Industrial Ethernet ESM (side view; dimensions in mm)

Cable Type	Space Required[1)]
9-pin sub-D connector for user assembly on ITP standard cable	approx. 160 mm
Preassembled Cables ITP standard cable 9/x ITP XP standard cable 9/x	 approx. 95 mm approx. 95 mm
Preassembled Cables TP Cord 9/x (horizontal cable outlet) ITP Cord 9/x (horizontal cable outlet)	 approx. 95 mm approx. 95 mm
TP Cord 9-45/x (45° cable outlet) TP XP Cord 9-45/x (45° cable outlet)	approx. 65 mm approx. 65 mm

1) for TP port and Standby-Sync port

9.4 ASGE Active Star Coupler

Front View of the ASGE Active Star Coupler

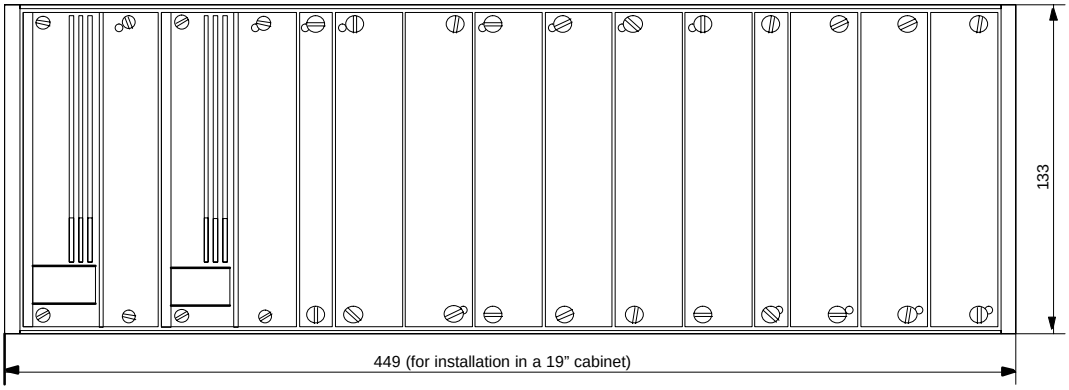


Figure 9-8 ASGE Active Star Coupler (front view; dimensions in mm)

Side View of the ASGE Active Star Coupler

Since the fiber-optic cable with its minimum bend radius and connector length takes the most space of all possible cables, it is used here as a guideline for the minimum clearance to the front of the ASGE active star coupler. At the back, space must be left for one or more power supply connectors.

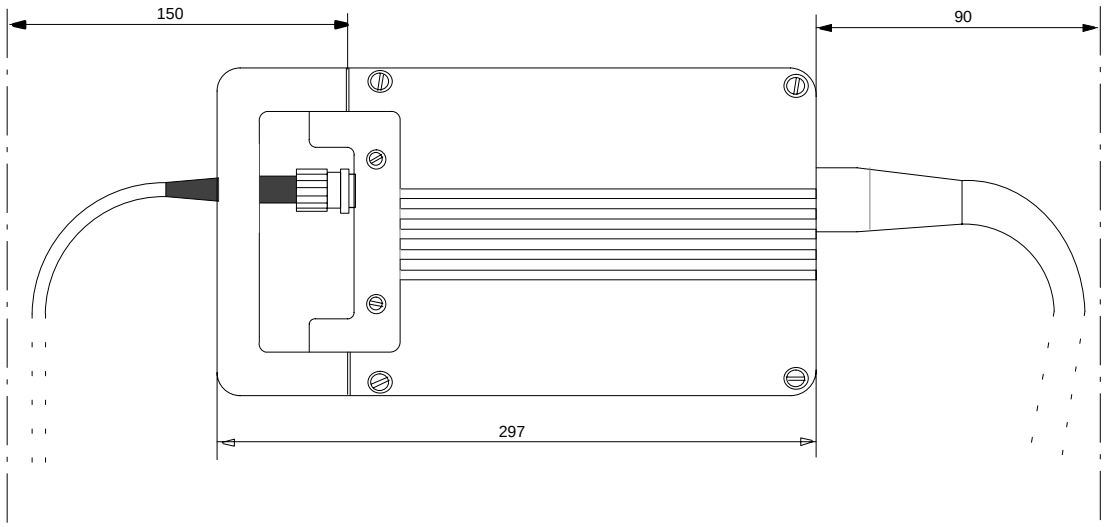


Figure 9-9 ASGE Active Star Coupler (side view; dimensions in mm)

9.5 Optical Transceiver

At both ends of the optical transceiver, a clearance of approximately 100 mm to the metal casing must be maintained for the AUI or fiber-optic cable. This distance is necessary to keep to the maximum bend radius with the connector length already included in the calculation (see, for example Figure 9-10).

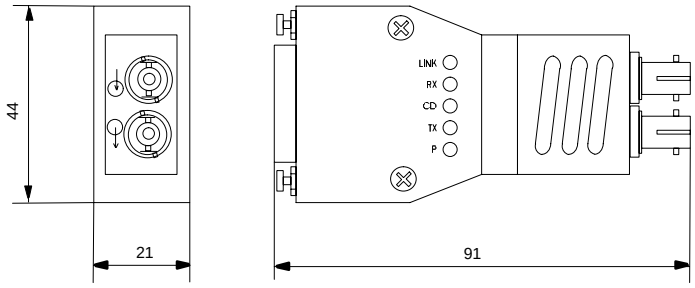


Figure 9-10 MINI-OTDE Optical Transceiver (dimensions in mm)

9.6 Mini UTDE RJ-45 Electrical Transceiver

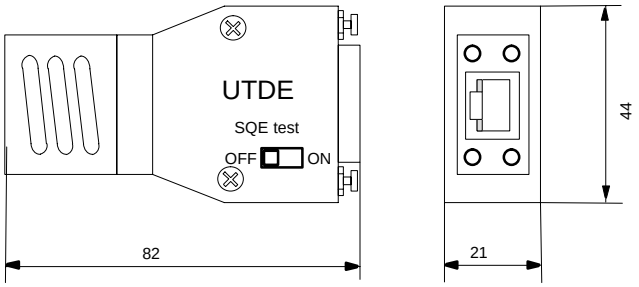


Figure 9-11 Mini-UTDE RJ-45 Electrical Transceiver (dimensions in mm)

9.7 Connectors

9-pin Sub-D Connector

The 9-pin sub D connector for user assembly and the version used on preassembled cables have different cable outlets. This results in different bend radii for the outgoing cable (see Figure 9-12 and Figure 9-13). The specified bend radii apply to the ITP standard cable.

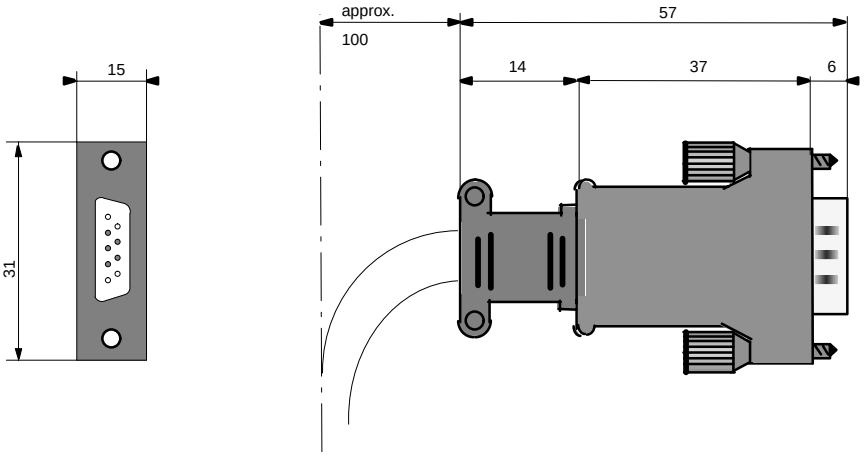


Figure 9-12 9-pin Sub-D Connector for User Assembly (dimensions in mm)

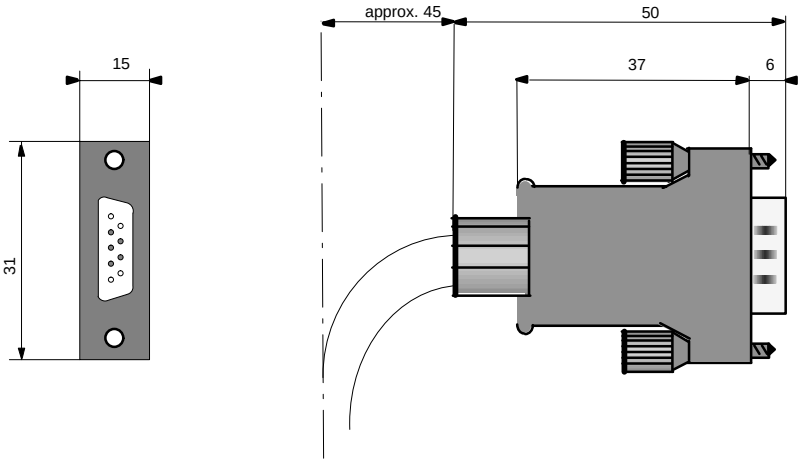


Figure 9-13 9-pin sub-D Connector on Preassembled Cable (dimensions in mm)

15-pin Sub-D Connector

The 15-pin sub D connector for user assembly and the version used on preassembled cables have different cable outlets. This results in different bend radii for the outgoing cable (see Figure 9-14 and Figure 9-15). The specified bend radii apply to the ITP standard cable.

The outlet direction of the cable can be adjusted in both connector versions in stages -30°, 0° (horizontal) and +30°.

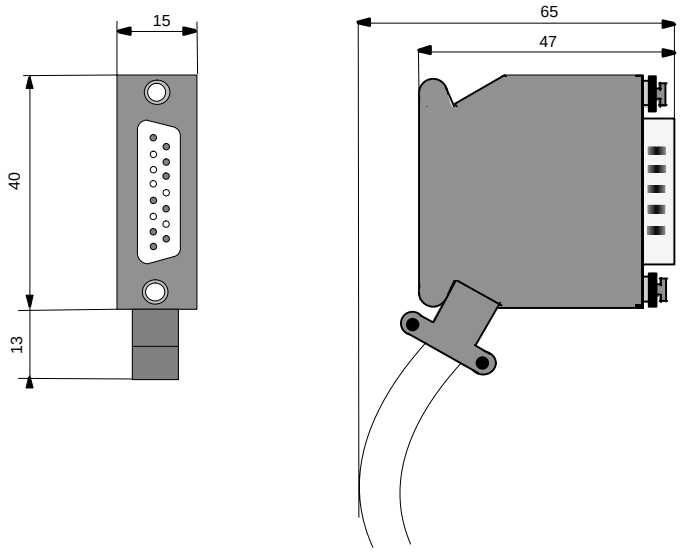


Figure 9-14 15-pin Sub-D Connector for User Assembly (dimensions in mm)

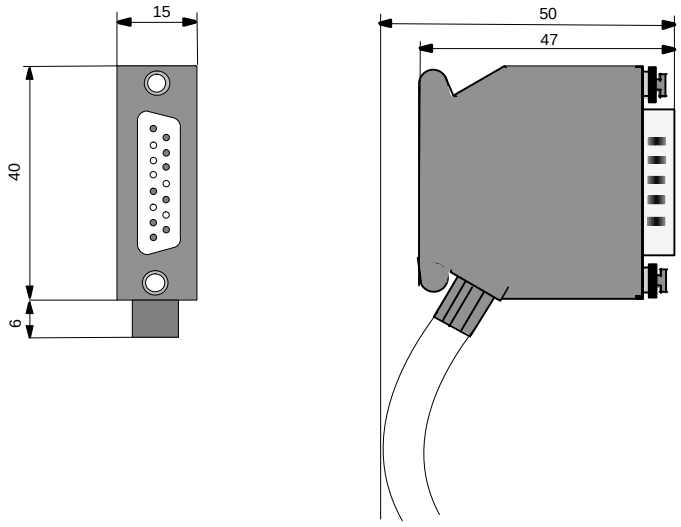


Figure 9-15 15-pin sub-D Connector on Preassembled Cable (dimensions in mm)

RJ-45 Connector

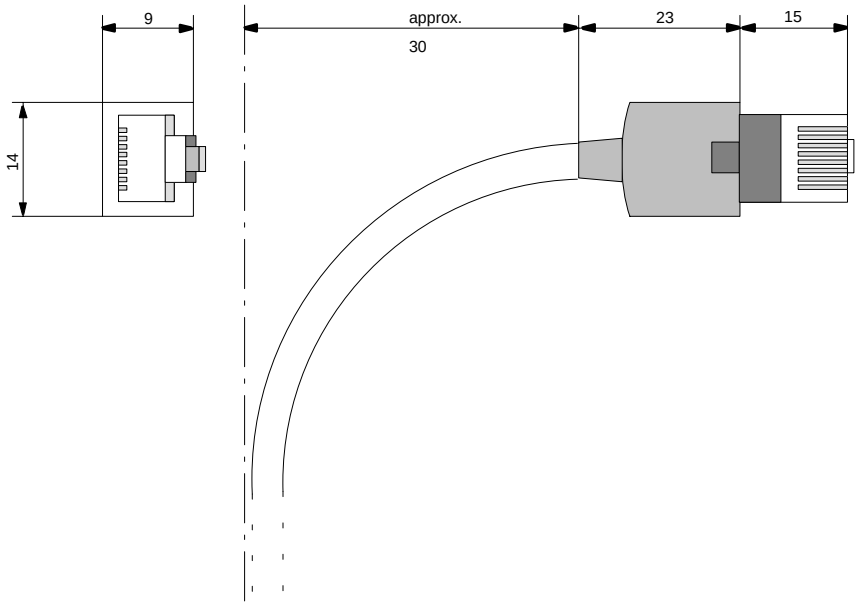


Figure 9-16 RJ-45 Connector (dimensions in mm)

9.8 Front View of the IE FC Outlet RJ-45

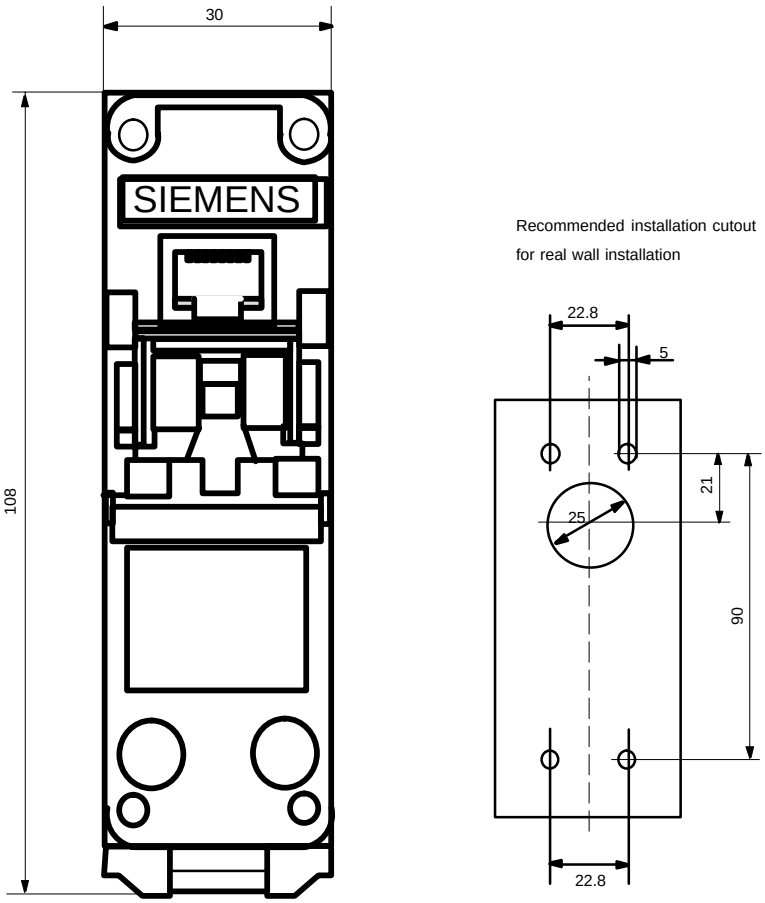


Figure 9-17 IE FC Outlet RJ-45 (dimensions in mm)

9.9 Side View of the IE FC Outlet RJ-45

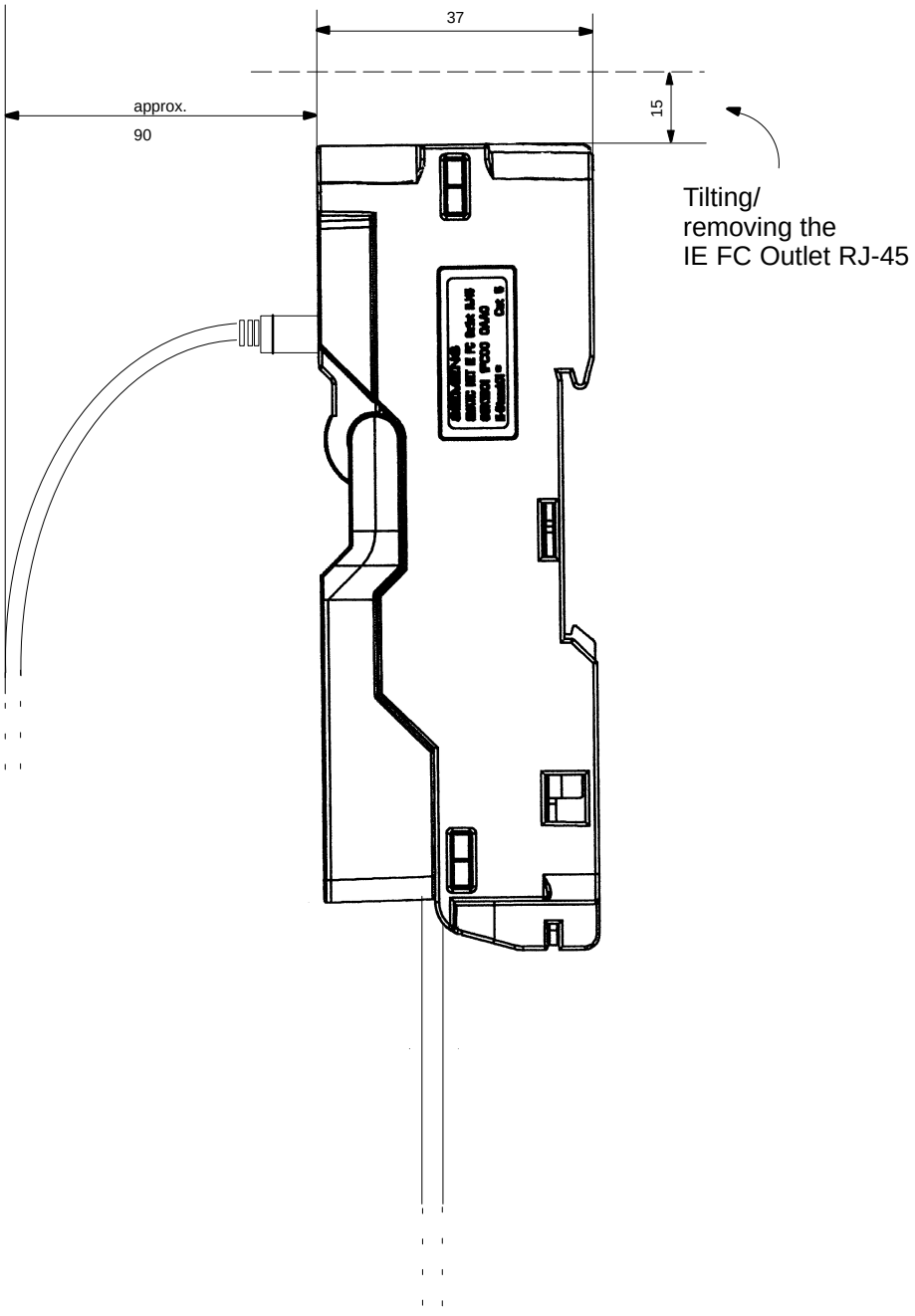


Figure 9-18 IE FC Outlet RJ-45 (dimensions in mm)

References

A

Manuals and Further Information

SIMATIC NET Industrial Ethernet is based on the following standards and directives:

/1/ ANSI/IEEE Std 802.3–1993 (ISO/IEC 8802–3: 1993)
Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

/2/ IEEE Std 802.3c–1985
Supplement to 802.3–Repeater Unit for 10 Mb/s Baseband Networks (Sections 9.1–9.8)

/3/ IEEE Std 802.3i–1990
Supplement to 802.3 – System Considerations for Multisegment 10 M/S Baseband Networks (Section 13) and Twisted Pair Medium Attachment Unit and Baseband Med Spec, Type 10BASE–T (Section 14)

/4/ IEEE 802.3j–1993
Supplement to 802.3 – Fiber Optic Active and Passive Star–Based Segments, Type 10BASE–F (Sections 15–18)

/5/ IEEE Std 802.3u–1995
Local and Metropolitan Area Networks–Supplement – Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units and Repeater for 100 MB/s Operation, Type 100BASE–T (Clauses 21–30)

The following manuals contain information on SIMATIC NET Industrial Ethernet:

/6/ SIMATIC NET Manual for Triaxial Networks
Order number: 6GK1970–1AA20–0AA1

/7/ SIMATIC NET Manual Ethernet (ASGE Star Coupler)
Order number: HIR: 943 320–001 German
Order number: HIR: 943 320–011 English

For information on SIMATIC NET OSM/ESM Network Management, refer to

/8/ SIMATIC NET OSM/ESM
Network Management, manual
This documentation is available on the CS manual server (http://www.ad.siemens.de/csi).
Search for entry ID 2928320

The following manuals contain information on networking SIMATIC programmable controllers:

/9/ SIMATIC S7–300 Programmable Controller,
Hardware and Installation Manual
SIEMENS AG
Part of the “S7–300, M7–300 Documentation Package,
Order number: 6ES7 398–8AA01–8AA1”

/10/ SIMATIC S7–400, M7–400 Programmable Controller,
Hardware and Installation Manual
SIEMENS AG
Part of the “S7–400, M7–400 Documentation Package,
Order number: 6ES7 498–8AA01–8AA1”

Order numbers

The order numbers of the SIEMENS documentation listed above can be found in the catalogs SIMATIC NET Industrial Communication, Catalog IK PI” and ”SIMATIC Components for Fully Integrated Automation, Catalog ST 70”.

You can order these catalogs and obtain further information and details of available training courses from your local SIEMENS office or national head office.

For information on information technology networking, refer to the following European standards:

/11/ EN 50173
Information Technology – Generic Cabling Systems.

/12/ EN 50174–1
Information Technology – Cabling System Installation
Part 1: Specification and Quality Assurance

/13/ EN 50174–2:2000
Information Technology – Cabling System Installation
Part 2: Installation Planning and Practices inside Buildings

/14/ EN 50174–3
Information Technology – Cabling System Installation
Part 3: Installation Planning and Practices outside Buildings

Standards on the Safety of Devices

/15/ EN 60529 / (IEC 60529)
Protection Provided by Enclosures (IP Code)

/16/ EN 60825–1 / (IEC 60825–1)
Safety of Laser Products
Part 1: Classification of Systems, Requirements and User Guidelines

/17/ EN 60825–2 / (IEC 60825–2)
Safety of Laser Products
Part 2: Safety of Optical Fiber Communication Systems

/18/ EN 60950 / (IEC 60950, modified)
Safety of Information Technology Equipment

/19/ EN 61010–1 / (IEC 61010–1, modified)
Safety Regulations for Electrical Equipment for Measurement, Control, and Laboratory Use

/20/ EN 61131–2 / (IEC 61131–2)
Programmable Controllers
Part 2: Equipment Requirements and Tests

European Standards for AC Distribution Systems, Grounding and Bonding Systems:

/21/ EN 50310:2000
Application of Equipotential Bonding and Earthing in Buildings with Information Technology

/22/ HD 384.3 S2
Electrical Installations of Buildings
Part 3: Assessment of General Characteristics
(IEC 60364–3:1993, modified)

/23/ HD 384.4.41 S2
Electrical Installations of Buildings
Part 4: Protection for Safety
Section 41: Protection against Electric Shock
(IEC 60364–4–41:1992, modified)

/24/ HD 384.4.47 S2
Electrical Installations of Buildings
Part 4: Protection for Safety
Chapter 47: Application of Protective Measures for Safety
Section 470.' General
Section 471: Measures for Protection against Electric Shock (IEC 60364–4–47:1981 + A 1:1993, modified)

/25/ HD 384.4.482 S1, Electrical Installations of Buildings
Part 4: Protection for Safety
Chapter 48: Choice of Protective Measures as a Function of external Influences
Section 482: Protection against Fire

/26/ HD 384.4.54 S1, Electrical Installations of Buildings
Part 5: Selection and Erection of Electrical Equipment
Chapter 54: Earthing Arrangements and protective Conductors
(IEC 60364–5–54:1980, modified)

International Standards for AC Distribution Systems, Grounding and Bonding Systems:

/27/ IEC 60364–3
Electrical installations of buildings;
part 3: Assessment of general characteristics

/28/ IEC 60364–4–41
Electrical installations of buildings
Part 4: Protection for safety
Chapter 41: Protection against electric shock

/29/ IEC 60364–4–47
Electrical installations of buildings.
Part 4 : Protection for safety.
Chapter 47 : Application of protective measures for safety.

/30/ IEC 60364–5–54
Electrical installations of buildings
Part 5: Selection and erection of electrical equipment
Chapter 54: Earthing arrangements and protective conductors

SIMATIC NET – Support and Training

B

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E-mail:	authorization@ nbgm.siemens.de	E-mail:	simatic.hotline@ sea.siemens.com	E-mail:	simatic.hotline@ sae.siemens.com.sg
GMT:	+1:00	GMT:	-5:00	GMT:	+8:00
The languages spoken on the hotlines are German and English. On the authorization hotline, French, Italian and Spanish are also available.					

Training Center

To help you become familiar with SIMATIC S7 programmable controllers, we offer training courses. Please contact your regional training center or the central training center in D 90327 Nuremberg.

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  - Using fax polling no. 08765 - 93 02 77 95 00
- Current Product Information leaflets and downloads which you may find useful for your product are available:
  - On the Internet at `http://www.ad.siemens.de/csi/net`
  - Via the Bulletin Board System (BBS) in Nuremberg (*SIMATIC Customer Support Mailbox)* under the number +49 (911) 895-7100.

    To access the mailbox, use a modem with V.34 (28.8 Kbps) capability whose parameters you should set as follows: 8, N, 1, ANSI, or dial in using ISDN (x.75, 64 Kbps).

Further Support

if you have further questions on SIMATIC NET products, please contact your Siemens representative in your local Siemens office.

You will find the addresses listed

- in our catalog IK PI
- on the Internet (http://www.ad.siemens.de)

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Fax (030) 386 -3 4921
Mobil (01 72) 3 07 95 44
E-Mail: Thomas.Gerlach@bln2.siemens.de

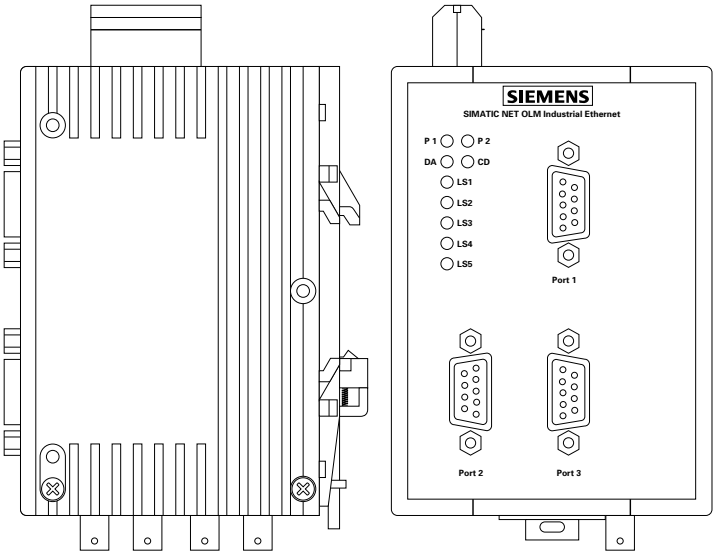
SIEMENS

SIMATIC NET Industrial Ethernet OLM V2.0 / ELM

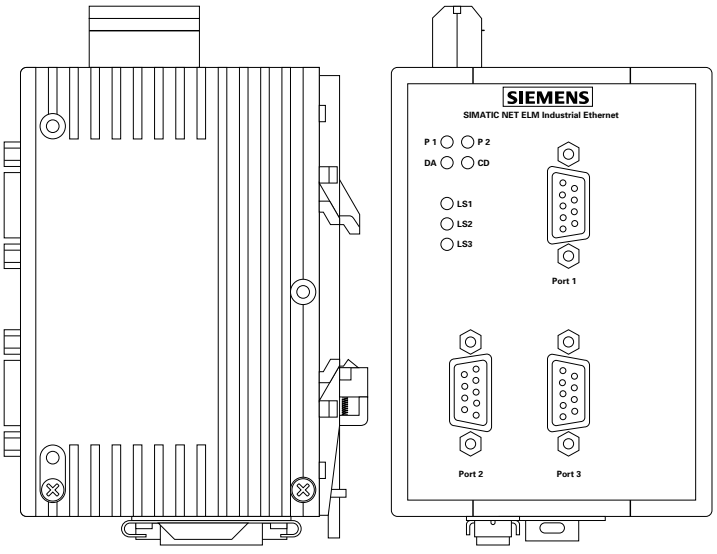
Description and operating instructions Link Modules for Industrial Ethernet

Order no.

6GK1102-4AA00/ 6GK1102-5AA00



Industrial Ethernet OLM V2.0



Industrial Ethernet ELM

The SIMATIC NET link modules for Industrial Ethernet allow Ethernet networks to be constructed flexibly in accordance with IEEE standard 802.3 using optical waveguide (F/O) and copper technology. The link modules provide several connection options in one piece of equipment and are plugged onto the standard bar.

The OLMs (optical link modules) have three industrial twisted pair (ITP) interfaces and two BFOC optical interfaces. It is possible to connect up to three pieces of terminal equipment or other ITP segments using ITPs, and F/Os can be used to connect up to two more pieces of terminal equipment or optical network components (OLM, ECFL2, Mini-OTDE, etc.).

Besides the three industrial twisted pair (ITP) interfaces, the ELMs (electrical link modules) have an AUI interface. It is possible to connect an Ethernet segment to a CSMA/CD local area network (LAN) with a transmission speed of 10 Mbit/s via the AUI interface.

Both modules conform to the specifications of ISO/IEC standard 8802-3.

You will find a detailed description of constructing a network with link modules and notes on network planning and installation in the “Industrial Twisted Pair” manual.

We have checked that the contents of the technical publication agree with the hardware and software described. However, it is not possible to rule out deviations completely, so we are unable to guarantee complete agreement. However, the details in the technical publication are checked regularly. Any corrections which prove necessary are contained in subsequent editions. We are grateful for suggestions for improvement.

We reserve the right to make technical modifications.

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Note

We would point out that the content of these operating instructions is not part of, nor is it intended to amend an earlier or existing agreement, permit or legal relationship. All obligations on Siemens arise from the respective purchasing agreement which also contains the full warranty conditions which have sole applicability. These contractual warranty conditions are neither extended nor restricted by comments in these operating instructions.

We would furthermore point out that for reasons of simplicity, these operating instructions cannot describe every conceivable problem associated with the use of this equipment. Should you require further information or should particular problems occur which are not treated in sufficient detail in the operating instructions, you can request the necessary information from your local Siemens office.

General

Electricity is used to operate this equipment. Comply in every detail with the safety requirements specified in the operating instructions regarding the voltages to apply!

⚠ **Warning!**
If warning notes are ignored, it is therefore possible for severe injuries and/or material damage to occur.

Only appropriately qualified staff should work on or near this equipment. Such staff must be thoroughly acquainted with all the warnings and maintenance measures contained in these operating instructions.

The proper and safe operation of this equipment assumes proper transport, appropriate storage and assembly and careful operation and maintenance.

Staff qualification requirements

Qualified staff within the meaning of these operating instructions or the warning notes are persons familiar with setting up, assembling, starting up and operating this product and who have appropriate qualifications to cover their activities, such as:

– training or instruction/entitlement to switch circuits and equipment/systems on and off, earth them and identify them in accordance with current safety standards;

– training or instruction in accordance with current safety standards in looking after and using appropriate safety equipment;

– first aid training.

Safety guidelines

Warning!
The OLM/ELM units are designed for operation with safety extra-low voltage. Accordingly, only safety extra-low voltages (SELV) to IEC950/EN60950/VDE0805 may be connected to the supply voltage connections.

1. Functional description

1.1 GENERAL FUNCTIONS

Signal regeneration
The OLM/ELM processes the signal shape and amplitude of the data received.

Retiming
In order to prevent jitter increasing over several segments, the OLM/ELM retimes the data to be transmitted.

Preamble regeneration
The OLM/ELM supplements lost preamble bits from data received to 64 bits (incl. the start of frame delimiter (SFD)).

Fragment extension
Collisions can cause short fragments to occur. If the OLM/ELM receives a fragment, this is supplemented to give the minimum length of 96 bits. This ensures reliable collision detection by all network participants.

Collision handling
If the OLM/ELM detects a data collision, it interrupts the transmission. For the duration of the collision, the collided data package is replaced by a jam signal to ensure collision detection by the terminal equipments.

Auto partitioning
Network failures can be caused by permanent occupancy, interrupted lines, lack of terminating resistors, damaged cable insulation and frequent collisions due to electromagnetic interference. In order to protect the network from such failures, the OLM/ELM in this case separates the segment in the receiving direction from the rest of the network.
The OLM/ELM has this auto partitioning function individually at each port. The other ports can thus continue to be operated without interference if one of the ports has been auto partitioned. In the event of auto partitioning, transmission continues into the ITP segment or the F/O line but reception at this port is blocked.

With twisted pair, auto partitioning is activated if
– a data collision lasts longer than 105 µs or
– there are more than 64 consecutive data collisions.

With F/O, auto partitioning becomes active when
– a data collision lasts longer than 1.5 ms (normal mode) or 0.2 ms (redundant mode) or
– there are more than 64 (normal mode) or 16 (redundant mode) consecutive data collisions.

Reconnection
The segment is reconnected to the network as soon as a package with the minimum length of 51 µs is received without collision at the relevant port, i. e. when the segment is working properly again.
When the redundant mode is active, packages >51 µs sent at a F/O port without collision also lead to reconnection.

Jabber control
Due to a defective bus coupler or LAN controller, for example, the network can be continuously occupied with data. To protect against this, the OLM/ELM interrupts reception
– at the affected ITP or AUI port after 5.5 ms. 9.6 µs after the end of the error the auto partitioning will be canceled. (jabber lockup protection)
– at the relevant F/O port after 3.9 ms. 420 ms after the end of the error the auto partitioning will be canceled. (Rx jabber)

1.2 SPECIFIC FUNCTIONS OF THE ITP INTERFACE

Link control
The OLM/ELM monitors the connected ITP line segments for short-circuit or interrupt using regular link test pulses in accordance with IEEE standard 802.3 10BASE-T. The OLM/ELM does not transmit any data in an ITP segment from which it does not receive a link test pulse.

Note: A non-occupied interface is assessed as a line interrupt. The ITP line to terminal equipment which is switched off is likewise assessed as a line interrupt as the de-energised bus coupler cannot transmit link test pulses.

Auto polarity exchange
If the reception line pair is incorrectly connected (RD+ and RD- switched) polarity is automatically reversed.

1.3 SPECIFIC FUNCTIONS OF THE F/O INTERFACE

Link control
The OLM monitors the connected F/O lines for interrupts using regular link test pulses in accordance with IEEE standard 802.3 10BASE-FL. The OLM transmits no data to an F/O line from which it is receiving no link test pulse.

Redundancy
In areas where data security has top priority, it is possible with the aid of the redundancy function to bridge any failure of an F/O line or OLM. To do so, a replacement line is frequently routed in a different cable run. In the event of a fault, there is an automatic switch between the main line and the replacement. A cross-link within the bus structure creates a ring (see Fig. 6). If any OLM link or OLM fails, every other OLM can still be reached with the aid of the redundant run.

1.4 DISPLAY ELEMENTS

Equipment status
The 4 LEDs on top provide information about statuses which affect the function of the entire OLM/ELM.
P1 – Power 1 (green LED)
– lit: supply voltage 1 present
– lit not: – supply voltage 1 not present,
– hardware fault in OLM/ELM

P2 – Power 2 (green LED)
– lit: supply voltage 2 present
– lit not: – supply voltage 2 not present,
– hardware fault in OLM/ELM

DA – Data (yellow LED)
– lit: OLM/ELM receiving data at at least 1 interface
– lit not: – OLM/ELM not receiving data at any interface,
– hardware fault in OLM/ELM
Depending on network load, the illumination of the LED can vary between a brief lighting up to permanent illumination.

CD – Collision Detect (red LED)
– lit: data collision detected at OLM/ELM level
– lit not: – no data collision at OLM/ELM level

Port Status ELM
These groups of LEDs display port-related information.
LS1 to LS3 - link status of the ITP ports (3 x green LED)
– lit: ELM receiving link test pulses from ITP segment,
– the ITP segment connected is working properly
– lit not: ELM is not receiving any link test pulses from ITP segment,
– the assigned ITP port is not connected,
– the equipment connected is switched off,
– the ITP line is interrupted or short-circuited

Port Status OLMV2.0
These groups of LEDs display port-related information.
LS1 to LS3 - link status of the ITP ports (3 x green LED)
– lit: OLM receiving link test pulses from ITP segment,
– the ITP segment connected is working properly
– flashes 2 times per period: port has auto partitioned
– lit not: OLM is not receiving any link test pulses from ITP segment,
– the assigned ITP port is not connected,
– the equipment connected is switched off,
– the ITP line is interrupted or short-circuited

LS4 – link status of F/O port 4 (green LED)
– lit: OLM receiving link test pulses from F/O segment,
– the F/O segment connected is working properly

– flashes 2 times
per period: port has auto partitioned
– lit not: OLM not receiving any link test pulses from F/O segment,
– the assigned F/O port is not connected,
– the equipment connected is switched off,
– the F/O receiving fibre is interrupted

LS5 – Link status of F/O port 5
(green LED)
Normal mode switched on
– lit: OLM receiving link test pulses from F/O segment,
– the connected redundant F/O segment is working properly
– flashes 2 times
per period: port has auto partitioned
– lit not: OLM not receiving any link test pulses from F/O segment,
– the assigned F/O port is not connected,
– the equipment connected is switched off,
– the F/O receiving fibre is interrupted

LS5 – Link status of F/O port 5
(green LED)
Redundant mode switched on
– lit: OLM receiving link test pulses from F/O segment,
– the connected redundant F/O segment is working properly **and** is active,
– flashes 1 time
per period: OLM receiving link test pulses from F/O segment,
– the connected redundant F/O segment is working properly **and** is in stand-by mode,
– lit not: OLM not receiving any link test pulses from F/O segment,
– the assigned F/O port is not connected,
– the equipment connected is switched off,
– the F/O receiving fibre is interrupted

1.5 CONTROLS

6-pin DIP switch
Using the 6-pin DIP switch on the top of the OLM/ELM housing
– the message about the link statuses can be suppressed by the indicator contact on a port-by-port basis. Using switches LA1 to LA5 (LA1 to LA3 on the ELM), the message about the link status of ports 1 to 5 (1 to 3 on ELM) is suppressed. State on delivery: switch position 1 (on), i.e. message not suppressed.
- port 5 can be switched to redundant mode (on the OLM). State on delivery: switch position 0 (off), i.e. port 5 in normal mode.

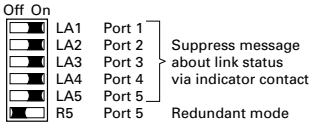

Fig. 1: 6-pin DIP switch on OLM

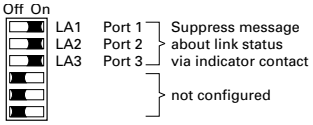

Fig. 2: 6-pin DIP switch on ELM

1.6 INTERFACES

ITP connection
Three 9-pin sub-D sockets enable three independent ITP segments to be connected. The socket casings are electrically connected to the front panel and thus connected to the housing of the OLM/ELM.

Mechanical locking is by means of a UNC 4-40 screw locking mechanism.
– **Pin configuration** of the 9-pin sub-D socket:
– TD+: pin 5, TD-: pin 9
– RD+: pin 1, RD-: pin 6
– remaining pins: not configured.

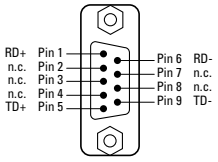

Fig. 3: Pin configuration of an ITP interface

AUI connection (ELM)
An AUI port to IEEE 802.3 enables ELM equipment to be connected to an Ethernet segment via a bus coupler. The data and CD lines of the AUI port are DC-decoupled from the supply voltages. The voltage (+ 12 V DC) to supply a bus coupler has the earth of the supply voltage as a reference potential.

Note: When connecting the ELM to a SINEC bus coupler with 2 interfaces (level 4 of issue or less), use only the left-hand interface of the coupler.

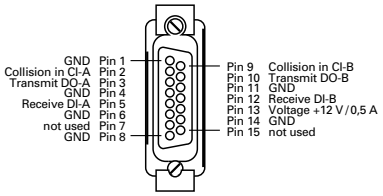
GND Pin 1
Collision in CI-A Pin 2
Transmit DO-A Pin 3
GND Pin 4
Receive DI-A Pin 5
GND Pin 6
not used Pin 7
GND Pin 8
Pin 9 Collision in CI-B
Pin 10 Transmit DO-B
Pin 11 GND
Pin 12 Receive DI-B
Pin 13 Voltage +12 V / 0,5 A
Pin 14 GND
Pin 15 not used

Fig. 4: Pin configuration of AUI interface

F/O connection (OLM)
2 optical ports to 10BASE-FL (BFOC/2.5 (ST) sockets) enable OLM equipment to be cascaded as well as redundant rings to be constructed using F/Os and terminal equipment to be connected.

5-pin terminal block
The supply voltage and the indicator contact are connected via a 5-pin terminal block with screw locking mechanism.

Warning!
The OLM/ELM equipment is designed for operation with SELV. Only safety extra-low voltages to IEC950/EN60950/VDE0805 may therefore be connected to the supply voltage connections and to the indicator contact.

– **Voltage supply**: The voltage supply can be connected to be redundant. Both inputs are decoupled. There is no load distribution. With redundant supply, the power pack supplies the OLM/ELM alone with the higher output voltage. The supply voltage is electrically isolated from the housing.

– **Indicator contact:** Contract interrupt indicates the following by means of a potential-free indicator contact (relay contact, closed circuit):
– the failure of at least one of the two supply voltages.
– a permanent fault in the link module (internal 5 V DC voltage, supply voltage 1 or 2 not in the permissible range).
– the faulty link status of at least one F/O (on OLM) or ITP port.
The indication of the link state might be masked on a port-by-port basis using DIP switches.
– at least one port has auto partitioned. Port 5 in redundant mode doesn't indicate the state „auto partitioning", because this function characterizes the error free state of the optical ring.

Note: In the case of the voltage supply being routed without redundancy, the OLM/ELM indicates the failure of a supply voltage. You can prevent this message by feeding in the supply voltage through both inputs.

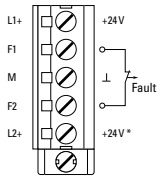

Fig. 5: Pin configuration of 5-pin terminal block

2. Configuration

2.1 LINE STRUCTURE

The OLM/ELM enables line structures to be built up. Cascading can be effected using both the ITP and F/O ports (OLM) or with a bus coupler via the AUI port (ELM).

☐ When cascading via ITP ports, use a cable which crosses the signal pairs, i.e. in each case connects output to input.

Detailed planning rules (cascade depth etc.) can be found in the "Industrial Twisted Pair Networks" manual.

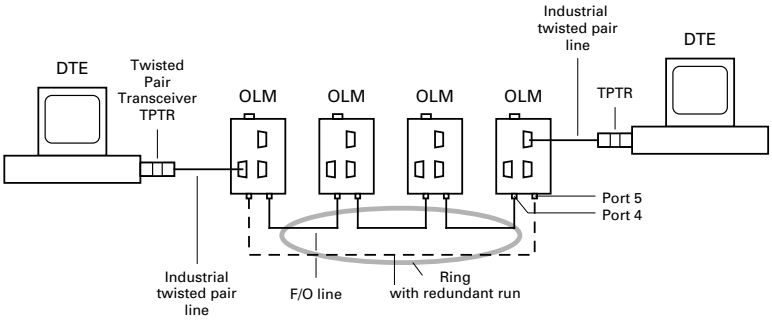

Fig. 6: Redundant ring structure via the F/O ports of the OLM equipments

2.2 REDUNDANT RING STRUCTURE (OLM)

Redundant ring structures can be built up using the F/O ports of the OLM. Figure 6 shows a redundant ring structure with OLM equipment. To do so, the first piece of equipment is connected to the last in the fiber optical line structure consisting of OLM equipment (see above) and the redundant fiber optical ring thus closed.

To do so, the redundant connection on precisely one of the two OLMs is to be connected to port 5, and port 5 switched to redundant mode. Switchover is effected at the 6-pin DIP switch on top of the equipment (see chapter entitled "Functional description - Controls".

Note: All the modules in the redundant ring may only be connected to one another via F/O runs (ECFL2, ECFL4).

2.3 COMBINATION WITH CONCENTRATORS OF THE ASGE, MC AND AMC FAMILY

The OLM/ELM can also be combined with concentrators of the ASGE, MC and AMC family. The OLM/ELMs can be cascaded for example in line structures via the ECFL2, ECFL4, ECTP3 etc. interface cards.

The number of pieces of equipment which can be cascaded depends on the overall network structure. Redundant ring structures can be implemented via the F/O ports (OLM).

Hints on calculating the maximum network expansion can be found in the Ethernet manual, Chapter 8 (see „Technical Data" for order number).

OLM
A maximum of 11 OLMs might be cascaded in a fiber optical line.
Here the total line length between the terminal equipments with the maximum distance might not exceed 1180 m.
The total line length is determined by the total sum of all F/O line sections and the two ITP lines to the terminal equipments.

ELM
A maximum of 13 OLMs/ELMs might be cascaded in an ITP line, with a maximum length of 100 m per ITP line.
A maximum of 2050 m total line length is allowed between two terminal equipments.

3. Assembly, startup procedure and dismantling

3.1 UNPACKING, CHECKING

– Check whether the package was delivered complete (see scope of delivery).
– Check the individual parts for transport damage.

⚠ **Warning!**
Use only undamaged parts!

3.2 ASSEMBLY

The equipment is delivered in a ready-to-operate condition. The following procedure is appropriate for assembly:
– Check whether the switch pre-setting suits your requirements.
– Pull the terminal block off the OLM/ELM and wire up the supply voltage and indicator lines.
– Fit the OLM/ELM on a 35 mm standard bar to DIN EN 50 022.
– Suspend the upper snap-in hook of the OLM/ELM in the standard bar, insert a screwdriver horizontally under the housing into the locking slide pull this downwards (cf. Fig. 8, Dismantling) and press the bottom of the module onto the standard bar until it locks in position (Fig. 7).
– Fit the signal lines.

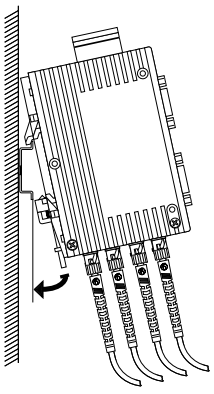

Fig. 7: Assembling the OLM/ELM

Notes:
– The housing of the OLM/ELM is grounded via the standard bar. There is no separate ground connection.
– The screws in the lateral half-shells of the housing may not be undone under any circumstances.
– The shielding ground of the industrial twisted pair lines which can be connected is electrically connected to the housing.

3.3 STARTUP PROCEDURE

You start up the OLM/ELM by connecting the supply voltage via the 5-pin terminal block. Lock the terminal block with the locking screw at the side.

3.4 DISMANTLING

To take the OLM/ELM off the standard bar, insert a screwdriver horizontally under the housing into the locking slide, pull it (without tipping the screwdriver) downwards and fold the OLM/ELM upwards (Fig. 8).

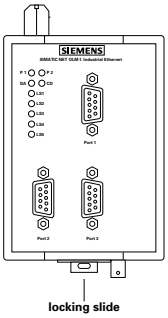

Fig. 8: Dismantling the OLM/ELM

4. Further support

In the event of technical queries, please talk to your Siemens contact in the agencies/offices responsible for looking after you. You can find the addresses
– in our IK10 catalogue
– and on the Internet (http://www.ad.siemens.de)

Our hotline is also at your disposal:
Tel: +49 911 895-7000 (Fax: -7001)

5. Technical data

General data

Operating voltage	DC 18 to 32 V safety extra-low voltage (SELV) (redundant inputs decoupled)
Current consumption	typ. 160 mA (OLM) respectively 80 mA (ELM) at 24 VDC (without AUI-load) max. 280 mA (OLM) respectively 430 mA (ELM) at 24 VDC (with AUI-load)
Overload current protection at input	non-changeable thermal fuse
Dimensions W x H x D	80 mm x 140 mm x 85 mm
Mass	OLM 900 g, ELM 850 g
Ambient temperature	0 °C to + 60 °C
Storage temperature	- 40 °C to + 80 °C
Humidity	10% to 90% (not-condensing)
Protection class	IP 30 (OLM), IP 40 (ELM)
Radio interference level Interference immunity	EN 55022 Class B EN 50082-2

Network size

Transition	ITP-Port ↔ ITP-Port (OLM, ELM)	F/O port ↔ F/O port (OLM)
Propagation equivalent	190 m	260 m
Variability Value	3 BT	3 BT
Transition	ITP-Port ↔ F/O port (OLM)	ITP-Port ↔ AUI-Port (ELM)
Propagation equivalent	360 m	190 m
Variability Value	6 BT	3 BT
F/O port (OLM ↔ OLM)		
Optical output power		
Graded-index fiber 50/125 µm (average)	min. -22,0 dBm	max. -16,2 dBm
Graded-index fiber 62,5/125 µm (average)	min. -19,0 dBm	max. -12,4 dBm
Optical input power	min. -33,0 dBm	
ITP line length (ITP-Port ↔ ITP-Port)		
Length of an industrial twisted pair segment	max. 100 m	
AUI line length (AUI-Port ↔ AUI-Port)		
Length of an AUI cable	max. 50 m	
F/O line length (example)		
50/125 µm fiber	max. 2.600 m	
62,5/125 µm fiber	max. 3.100 m	

Scope of delivery

SIMATIC NET Industrial Ethernet
OLM V2.0/ELM incl.
terminal block for supply voltage
description and operating instructions

Order number

SIMATIC NET Industrial Ethernet OLM V2.0	6GK1102-4AA00
SIMATIC NET Industrial Ethernet ELM	6GK1102-5AA00

Accessories

"Industrial Twisted Pair Networks" manual	6GK1970-1BA00-0AA0
Ethernet manual	HIR:943 320-011

CE **Notes on CE identification**
The link modules for Industrial Ethernet comply with the regulations of the following European directive:

89/336/EEC
Council Directive on the harmonisation of the legal regulations of member states on electromagnetic compatibility (amended by Directives 91/263/EEC, 92/31/EEC and 93/68/EEC).

Area used	Requirements for emitted interference	interference immunity
Residential	EN 50081-1: 1992	EN 50082-1: 1992
Industrial	EN 50081-2: 1993	EN 50082-2: 1995

The EU declaration of conformity is kept available for the responsible authorities in accordance with the above-mentioned EU directives at:

Siemens Aktiengesellschaft
Bereich Automatisierungs- und Antriebstechnik
Industrielle Kommunikation (A&D PT2)
Postfach 4848
D-90327 Nürnberg

The product can be used in the residential sphere (residential sphere, business and trade sphere and small companies) and in the industrial sphere.

The precondition for compliance with EMC limit values is strict adherence to the construction guidelines specified in this description and operating instructions and in the "Industrial Twisted Pair Networks" manual!

737 211-002-01-0298
Printed in Germany

SIEMENS

SIMATIC NET

Industrial Ethernet OSM/ESM

Operating Instructions

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C79000-Z8976-C068-04

Release 4 2001/2002

Safety Guidelines

These operating instructions contain notices which you should observe to ensure your own personal safety as well as to protect the product and connected equipment. These notices are highlighted in the manual by a warning triangle and are marked as follows according to the level of danger:

Danger

indicates that death, severe personal injury or substantial property damage **will** result if proper precautions are not taken.

Warning

indicates that death, severe personal injury or substantial property damage **can** result if proper precautions are not taken.

Caution

indicates that minor personal injury or property damage can result if proper precautions are not taken.

Note

draws your attention to particularly important information on the product, handling the product, or to a particular part of the documentation.

Qualified Personnel

Only qualified personnel should be allowed to install and work on this equipment . Qualified persons are defined as persons who are authorized to commission, to ground, and to tag circuits, equipment, and systems in accordance with established safety practices and standards.

Correct Usage

Note the following:

Warning

This device and its components may only be used for the applications described in the catalog or the technical description, and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens.

This product can only function correctly and safely if it is transported, stored, set up, and installed correctly, and operated and maintained as recommended.

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Siemens AG
Bereich Automatisierungs- und Antriebstechnik
Geschäftsgebiet Industrie-Automatisierungssysteme
Postfach 48 48, D-90327 Nürnberg

Disclaimer

We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvement are welcome.

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Subject to technical change.

Siemens Aktiengesellschaft

Printed in the Federal Republic of Germany

Preface

Purpose of the Operating Instructions

These Operating Instructions support you during configuration, commissioning, and troubleshooting in networks with OSM ITP62, OSM ITP62-LD, OSM ITP53, ESM ITP80, OSM TP62, and ESM TP80.

The Package

The OSM/ESM includes the following components:

- OSM / ESM device
- 6-pin plug-in terminal block
- Kit for wall mounting or mounting in 19" cubicle
- Product information bulletin
- CD

Installing an OSM/ESM

- Follow the instructions in Chapter 5 of these operating instructions.

Validity of the Operating Instructions

These operating instructions are valid for the following devices:

- OSM ITP62
- OSM ITP62-LD
- OSM ITP53
- ESM ITP80
- OSM TP62
- ESM TP80

Further Documentation

The OSM/ESM Network Management manual describes how to operate the OSM/ESM with network management.

The "SIMATIC NET Industrial Twisted Pair and Fiber Optic Networks" manual contains further information if you want to connect the OSM/ESM to other SIMATIC NET network components (for example OLM, ELM) or if you want to connect entire network segments to an OSM/ESM.

The manual "Triaxial Networks for Industrial Ethernet" contains instructions on creating triaxial networks that you can connect via an ELM to an OSM/ESM.

Finding Information

To help you to find the information you require more quickly, the manual includes not only the table of contents but also the following sections in the Appendix:

- Glossary
- Index

Guide to the Manual

To help you to find specific information quickly, these operating instructions include the following parts:

- At the front of the operating instructions you will find a complete table of contents.
- The chapters have headings in the left margin with an overview of the contents of the paragraphs in the section.
- Following the appendix, you will find a Glossary in which the most important specialist terms used in the instructions are defined.
- At the back of the operating instructions, you will find an index with which you can find topics quickly.

Audience

These Operating Instructions are intended for personnel involved in configuration, commissioning, and troubleshooting in networks with OSM ITP62, OSM ITP62-LD, OSM ITP53, ESM ITP80, OSM TP62, and ESM TP80.

Personnel Qualification Requirements

Only qualified personnel should be allowed to install and work on this equipment . Qualified personnel as referred to in the operating instructions or in the warning notes are defined as persons who are familiar with the installation, assembly, startup and operation of this product and who possess the relevant qualifications for their work, e.g.:

- Training in or authorization for connecting up, grounding or labeling circuits and devices or systems in accordance with current standards in safety technology;
- Training in or authorization for the maintenance and use of suitable safety equipment in accordance with current standards in safety technology;
- First Aid qualification.

Standards and Approvals

The OSM /ESM meets the requirements for the CE mark. For more detailed information about approvals and standards, refer to the appendix.

Recycling and Disposal

OSMs/ESMs are suitable for recycling due to the low levels of harmful substances they contain

For environmentally-friendly recycling and disposal of your old OSM/ESM, please contact:

Siemens Aktiengesellschaft
Anlagenbau und Technische Dienstleistung
ATD ERC Essen Recyling/Remarketing
Fronhauser Str. 69
45 127 Essen

Tel: +49-201-816-1540 (Hotline)
Fax: +49-201-816-1506

Documentation Feedback

To help us to provide the best possible documentation for you and future OSM/ESM users, we need your support.

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Introduction 1

The switching technology of the Industrial Ethernet OSM Version 2/ESM (Optical/Electrical Switching Module) allows the structuring of Ethernet networks with large spans and large numbers of nodes. It simplifies network configuration and network expansions. The OSM Version 2/ESM are simply called OSM/ESM in the rest of this manual.

The OSMs have both electrical ports and additional FO ports via which several of these devices can be interconnected to form an optical bus or ring configuration. ESMs only have electrical ports.

DTEs, other OSMs/ESMs or complete network segments operating at 10 or 100 Mbps can be connected to the electrical auto-negotiation (autosensing) ports of the OSM/ESM. The transmission rate is detected automatically.

To increase availability, ring configurations can be created with OSMs or ESMs. To do this, OSMs or ESMs are first connected together to form a bus (via ports 7 and 8) . The two ends of the rings are closed by an OSM or ESM operating in the RM (redundancy manager) mode.

The OSM or ESM operating in the RM mode monitors the attached bus and allows a connection through it if it detects an interruption on the attached bus; in other words, it reestablishes a function bus. Reconfiguration is completed within 0.3s. An OSM/ESM is switched over to the RM mode using a DIP switch on the device.

The redundant standby coupling allows the redundant coupling of OSM/ESM or OLM rings. To do this, two OSM/ESMs (one operating in standby mode) are connected via their standby sync ports.

In the ITP variants of the OSM/ESM, the DTEs are attached using the particularly robust Industrial Twisted Pair (ITP) connector with its high immunity to noise. In the TP variants, the DTEs are connected via RJ-45 female connectors.

The Version 2 OSMs are compatible with the previous OSM variants (6GK 1105-0AA00) and ORM (6GK1105-1AA00) and can, for example, be mixed with these in an optical ring.

This manual describes the functions of the OSM/ESM available without using network management. The OSM/ESM Network Management user manual describes the additional options available if you use network management.

1.1 Overview of the Variants of the OSM/ESM

1.1.1 OSM ITP62

Possible Attachments

The OSM ITP62 allows attachment of up to 6 DTEs or network segments using the ITP connector. By coupling an OSM via ports 7 and 8 it is possible to create optical bus and ring structures. The OSM ITP62 can be coupled with other OSM ITP62, OSM ITP53 and OSM TP62 modules via the optical ports.

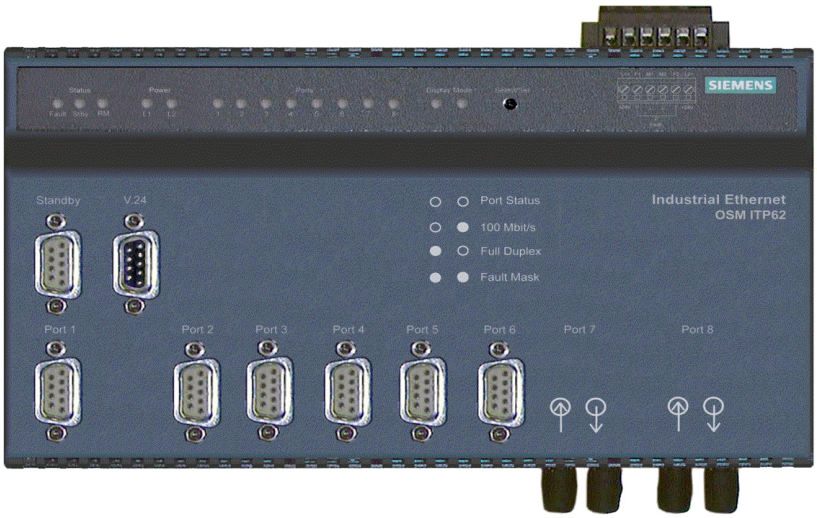


Figure 1: OSM ITP62

Properties of the OSM ITP62	
Electrical ports	6x 10/100 Mbps auto-negotiation ports with ITP connector (sub-D 9-pin female)
Optical ports	2 x 100 Mbps FO ports (full duplex) BFOC female connector
Maximum distance between two OSMs	3000 m (multimode graded-index fiber)
Maximum ring span with 50 OSMs	150 km

1.1.2 OSM ITP62-LD

Possible Attachments

The OSM ITP62-LD is suitable for spanning extremely long distances. With the monomode fiber, distances of up to 26 km are possible between two OSM ITP62-LD modules. By coupling an OSM ITP62-LD via ports 7 and 8 it is possible to create optical bus and ring structures.

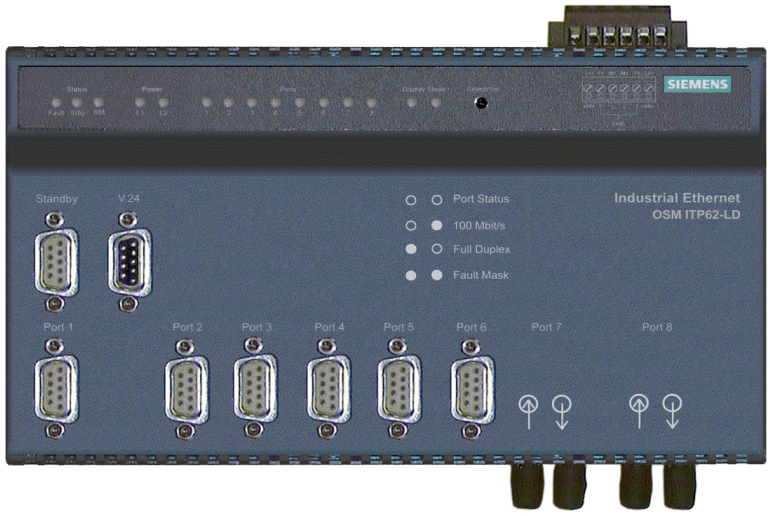


Figure 2: OSM ITP62-LD

Properties of the OSM ITP62-LD	
Electrical ports	6x 10/100 Mbps auto-negotiation ports with TP connector (sub-D 9-pin female)
Optical ports	2 x 100 Mbps FO ports (full duplex) BFOC female connector
Maximum distance between two OSM ITP62-LD	26 km (monomode fiber)
Maximum ring span with 50 OSM ITP62-LD	1300 km

OSM ITP62-LD modules can only be coupled to other OSM ITP62-LD modules by the optical ports.

1.1.3 OSM ITP53

Possible Attachments

The OSM ITP53 allows the attachment of 5 DTEs or network segments with the ITP connector. By coupling an OSM via ports 7 and 8 it is possible to create optical bus and ring structures. The OSM ITP53 can be coupled with other OSM ITP53, OSM ITP62 and OSM TP62 modules via the optical ports.

The additional FO port of the OSM ITP53 (port 1) also allows redundant coupling of rings via fiber-optic cables (see Section 3.3).

Figure 3: OSM ITP53

Properties of the OSM ITP53	
Electrical ports	5 x 10/100 Mbps auto-negotiation ports with ITP connector (sub-D 9-pin female)
Optical ports	3 x 100 Mbps FO ports (full duplex) BFOC female connector
Maximum distance between two OSMs	3000 m (multimode graded-index fiber)
Maximum ring span with 50 OSMs	150 km

1.1.4 ESM ITP80

Possible Attachments

Up to 8 DTEs or network segments with ITP connector can be attached to an ESM ITP80. By coupling an ESM via ports 7 and 8 it is possible to create bus and ring structures.

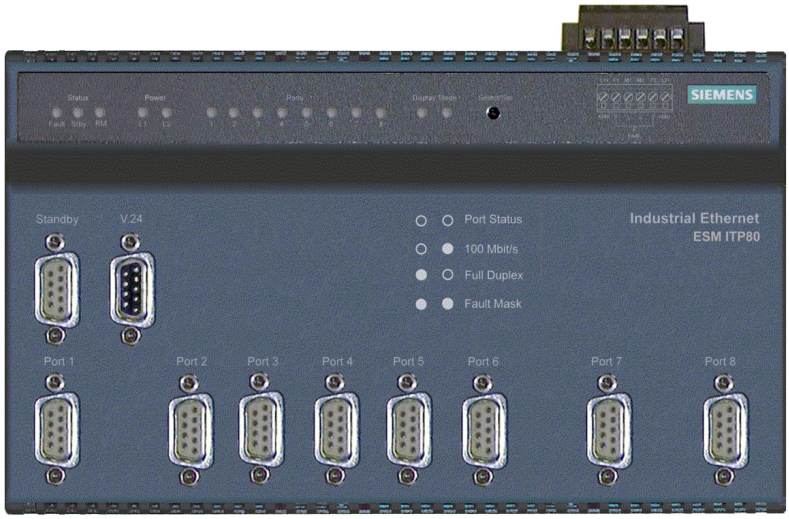


Figure 4: ESM ITP80

Properties of the ESM ITP80	
Electrical ports	8x 10/100 Mbps auto-negotiation ports with ITP connector (sub-D 9-pin female)
Optical ports	none
Maximum distance between two ESMs	100 m
Maximum ring span with 50 ESMs	5 km

1.1.5 OSM TP62

Possible Attachments

The OSM TP62 allows attachment of up to 6 DTEs or network segments using the TP connector. The OSM TP62 is particularly suited for use in areas with low noise levels (for example switching cubicles). By coupling an OSM via ports 7 and 8 it is possible to create optical bus and ring structures. The OSM TP62 can be coupled with other OSM TP62, OSM ITP53 and OSM ITP62 modules via the optical ports.

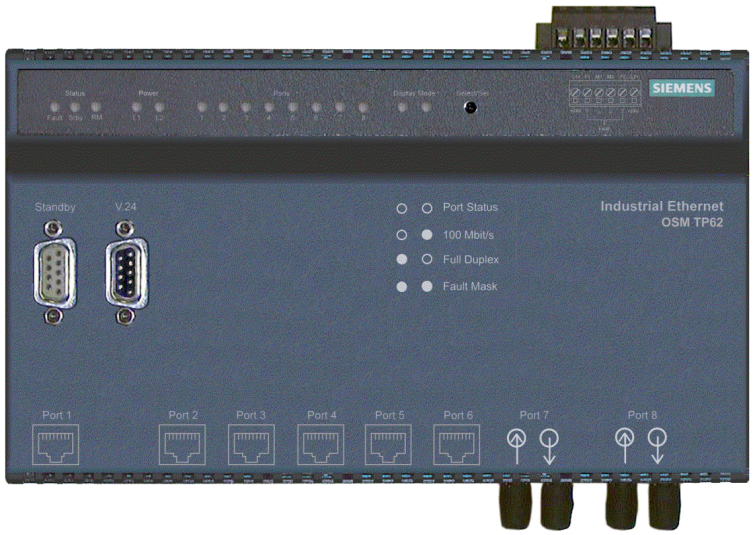


Figure 5: OSM TP62

Properties of the OSM TP62	
Electrical ports	6x 10/100 Mbps auto-negotiation ports with TP connector (RJ-45 female)
Optical ports	2 x 100 Mbps FO ports (full duplex) BFOC female connector
Maximum distance between two OSMs	3000 m (multimode graded-index fiber)
Maximum ring span with 50 OSMs	150 km

1.1.6 ESM TP80

Possible Attachments

The ESM TP80 allows attachment of up to 8 DTEs or network segments using the TP connector (RJ-45 female). The ESM TP80 is particularly suited for use in areas with low noise levels (for example switching cubicles). By coupling an ESM TP80 via ports 7 and 8 it is possible to create bus and ring structures.

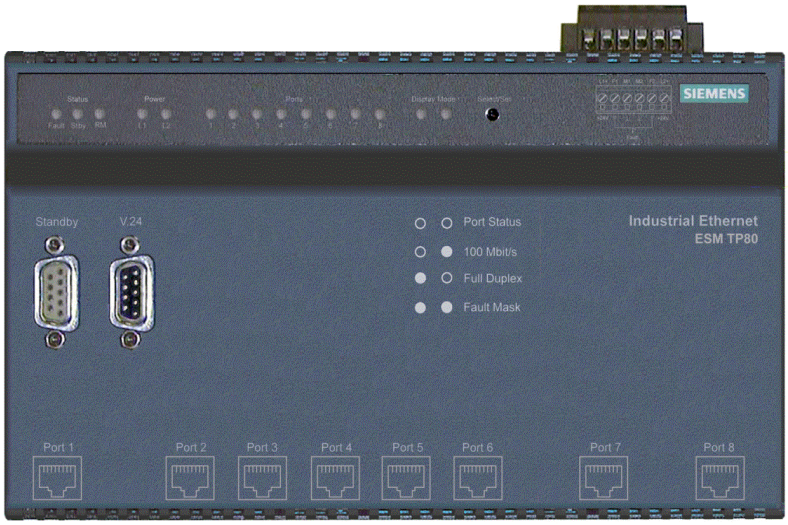


Figure 6: ESM TP80

Properties of the ESM TP80	
Electrical ports	8x 10/100 Mbps auto-negotiation ports with TP connector (RJ-45 female)
Optical ports	none
Maximum distance between two ESM ITP80 modules	100 m
Maximum ring span with 50 ESM ITP80 modules	5 km

Functions 2

This chapter discusses the general functions of the OSM/ESM, in particular the properties of the switching technology.

Increased Network Performance

By filtering the data traffic based on the Ethernet (MAC) address of the DTEs, local data traffic remains local, only data intended for nodes in another network segment are passed on by the OSM or ESM. This reduces the data traffic in the network segments and lowers the network load in the network segments.

Simple Network Configuration and Network Expansion

OSMs and ESMs store the data received at the ports and the direct it to the destination address. The restriction of the network span resulting from collision detection (CSMA/CD) ends at the OSM/ESM port. With multimode graded-index fibers, a total network span of up to 150 km and more can be achieved without problems. With the OSM ITP62-LD, the monomode fibers allow a network span of up to 1300 km.

Limitation of Errors to the Network Segment Affected

OSMs and ESMs only pass on valid data. Invalid packets are discarded so that bad packets within a network segment have no effect on any other segment attached to the OSM/ESM.

Learning Addresses

By evaluating the source addresses in the data packets, OSMs/ESMs automatically learn the addresses of the DTEs attached via a particular port. If an OSM/ESM receives a data packet, it directs this packet only to the port via which the appropriate DTE can be obtained.

An OSM/ESM can learn up to 12000 addresses.

Deleting Addresses

An OSM/ESM monitors the age of the addresses it has learnt - address entries that exceed a certain age (aging time on the OSM/ESM 40 seconds) are deleted again by the OSM/ESM. If a packet with a source address matching the address entry is received before the aging time elapses, the address entry is retained and the age of the address is set to 0 again. When the OSM/ESM is restarted, the address entries are also deleted. If a packet is received by a OSM/ESM for which there is no address entry, the OSM/ESM distributes it to all ports.

Setting the Transmission Rate, Auto-negotiation

The electrical ports of the OSM/ESM are set to the auto-negotiation (autosensing) mode.

They automatically detect the transmission rate (10 or 100 Mbps) at which the attached device or attached network segment operates and set themselves to this rate. If the partner device also supports the auto-negotiation mode, the devices further negotiate whether they will exchange data with each other in the half duplex or full duplex mode.

As a result of the automatic adaptation to the transmission rate of the attached DTEs, existing network segments operating at 10 or 100 Mbps can be interconnected simply using OSMs/ESMs.

Note

If the partner device connected to a port of an OSM/ESM does not support the auto-negotiation mode (for example OSM Version 1), the port of the partner device must be set to half duplex mode.

Packets with the VLAN Priority Tag

Please note the following:

1. The OSM/ESM **does not** support packets with VLAN tags according to IEEE 802.1Q. Configure your network so that no packets with VLAN tags are transmitted via the OSM/ESM.

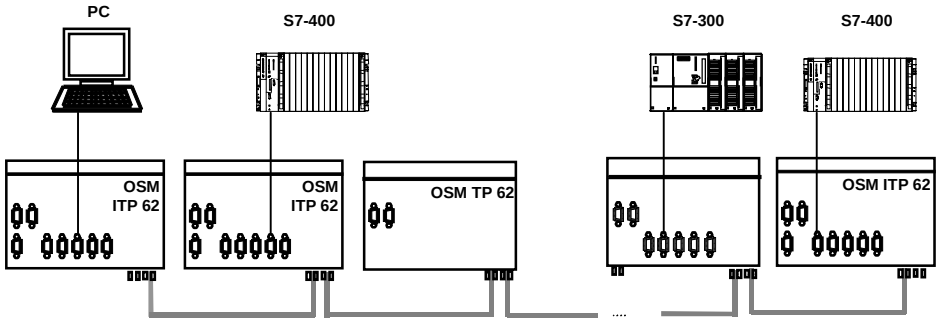
2. Your network should be designed so that no packets with a priority tag and a priority higher than 3 (IEEE 802.1p) are transmitted via the OSM/ESM since these packets can influence redundancy functions (for example, longer switchover times if a fault develops).

Network Topologies with OSM/ESM

3

3.1 Bus Structure

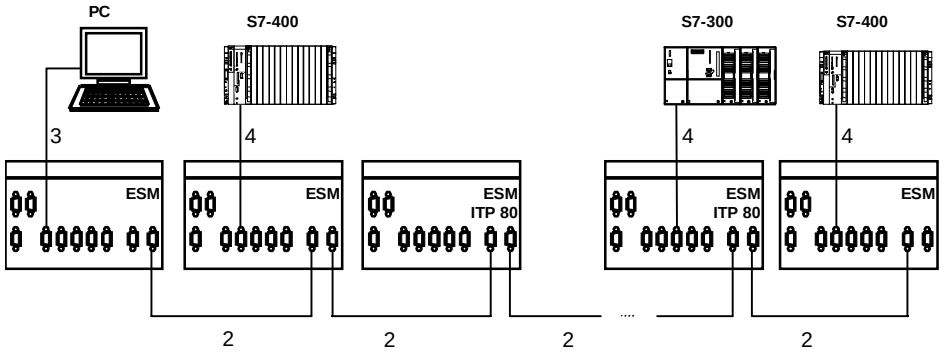
With OSMs or ESMs, bus structures can be implemented . The cascading depth and total span of a network are limited only by the monitoring times of the communication connections. These times must always be set higher than the signal delay of the transmission path.



1 Fiber-optic cable (FO)
3 TP cord 9/RJ45
4 ITP standard cable 9/15

Figure 7: Bus with OSM

Apart from OSM ITP62-LD modules, all listed OSM variants can be used in any combination in a bus consisting of OSMs. OSM ITP62-LD modules can only be coupled with other OSM ITP62-LD modules via the optical ports (monomode fiber).



2 ITP XP standard cable 9/9
3 TP cord 9/RJ45
4 ITP standard cable 9/15

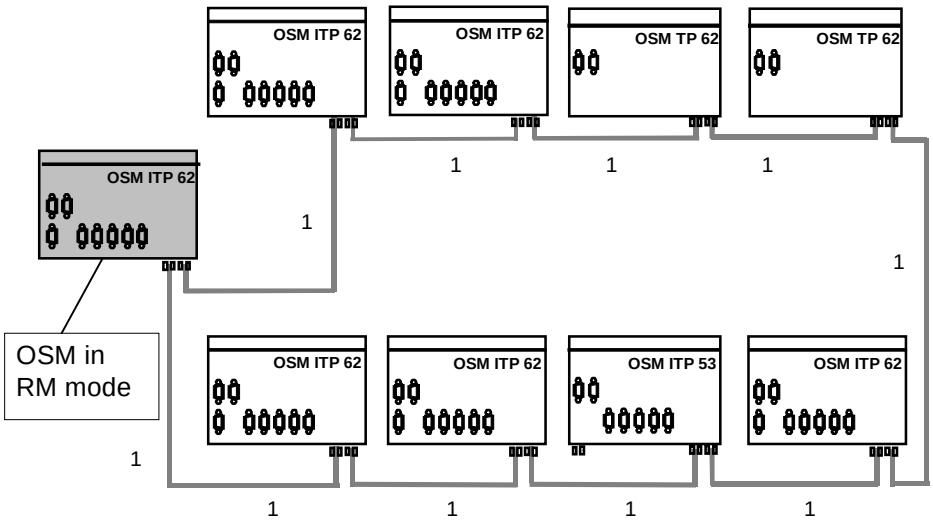
Figure 8: Bus with ESMs

In a bus consisting of ESMs, both ESM ITP80 modules and ESM TP80 modules can be used. (Connecting cable to couple the two variants available on request).

3.2 Redundant Ring Structure

With the aid of an OSM functioning as the redundancy manager (RM), both ends of an optical bus made up of OSMs can be closed to form a redundant optical ring. The OSMs are connected together using ports 7 and 8.

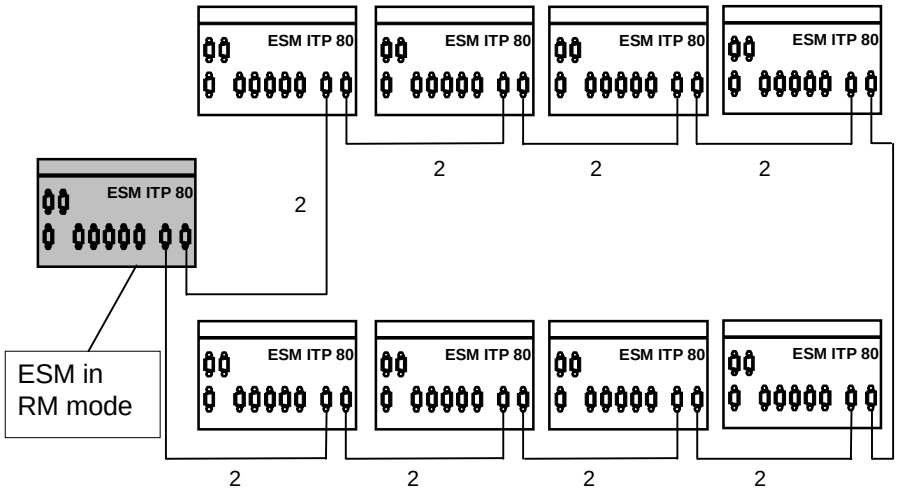
The RM monitors the OSM bus connected to it, closes the bus if it detects and interruption and therefore reestablishes a functioning bus configuration. A maximum of 50 OSMs are permitted in an optical ring. This allows reconfiguration time of less than 0.3 s to be achieved. The RM mode is activated on the OSM using a DIP switch (Section 4.2.4.1).



1 Fiber-optic cable (FO)

Figure 9: Redundant Ring Structure with OSMs

A redundant electrical ring can be established using ESMs in the same way. To achieve this the ESMs are connected together using ports 7 and 8. One device must be switched to the redundancy manager mode. With ESMs and a maximum of 50 devices in the ring, a reconfiguration time of less than 0.3 s can also be achieved.



2 ITP XP standard cable 9/9

Figure 10: Redundant Ring Structure with ESMs

Notes

- The reconfiguration time of less than 0.3 s can only be achieved when no components other than OSMs and ESMs (for example switches) are used in the redundant ring.
- In a ring, one device and one device only must operate in the redundancy manager mode.
- DTEs or complete network segments can be attached to ports 1 - 6 of an OSM/ESM operating in the RM mode.

3.3 Redundant Coupling of Network Segments

The standby sync port allows the connection of two Industrial Ethernet OSMs or ESMs with one operating as standby master (DIP switch "Stby off") and the other as standby slave (DIP switch "Stby on"). With this mode, pairs of OSMs/ESMs can be used for redundant coupling of OSM/ESM or OLM rings.

With network management, the OSM/ESM can also be configured so that several rings or networks can be interconnected at the same time with two OSMs/ESMs (see OSM/ESM Network Management, User Manual).

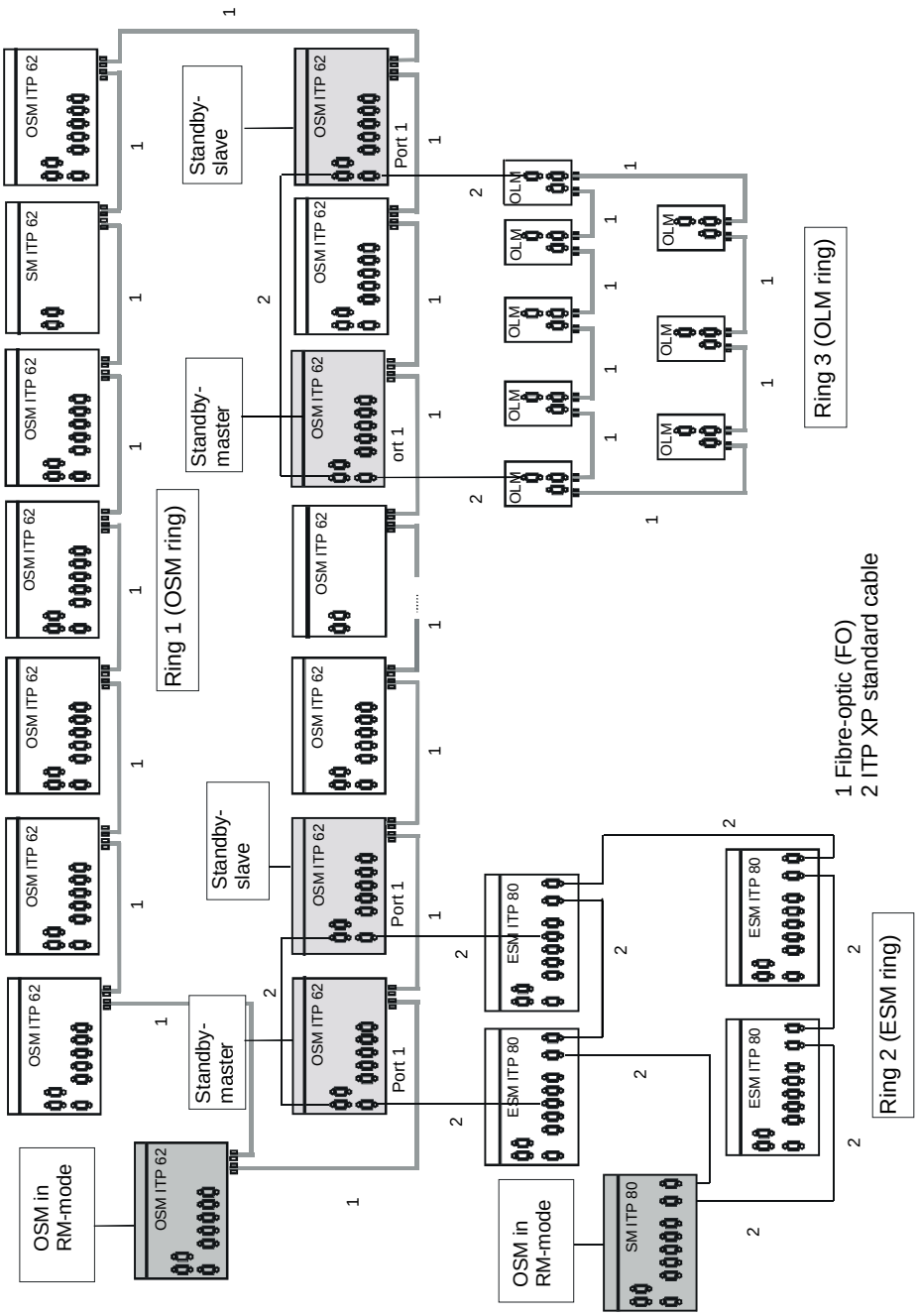


Figure 11: Redundant Coupling of Network Segments

The connection between two network segments is on two separate paths. Two of the OSMs/ESMs in a ring are connected together via a connecting cable (ITP-XP standard cable 9/9 with a maximum length of 40 m) and inform each other of their operating states. One of these OSMs/ESMs is assigned the redundant function using the DIP switch setting "Stby on" (standby slave). The other OSM takes over the function of the standby master (DIP switch setting "Stby off").

Immediately following the failure of the main transmission path, the standby slave enables the redundant path. If the main path is OK again, the standby master informs the standby slave. The main path is enabled and the redundant path disabled again. The reconfiguration time of the redundant ring coupling is less than 0.3 s.

Port Assignment in the Standby Mode

On the standby master and standby slave **only port 1** (standby port) can be used for the coupling to the neighboring ring. Ports 2 - 6 can be used just as normal OSM ports.

With network management, it is also possible to configure ports other than port 1 as standby ports (See also OSM/ESM Network Management User Manual)

Simultaneous Standby and Redundancy Manager Operation

A standby master or standby slave can adopt the function of a redundancy manager at the same time.

Replacing the Standby Master During Operation

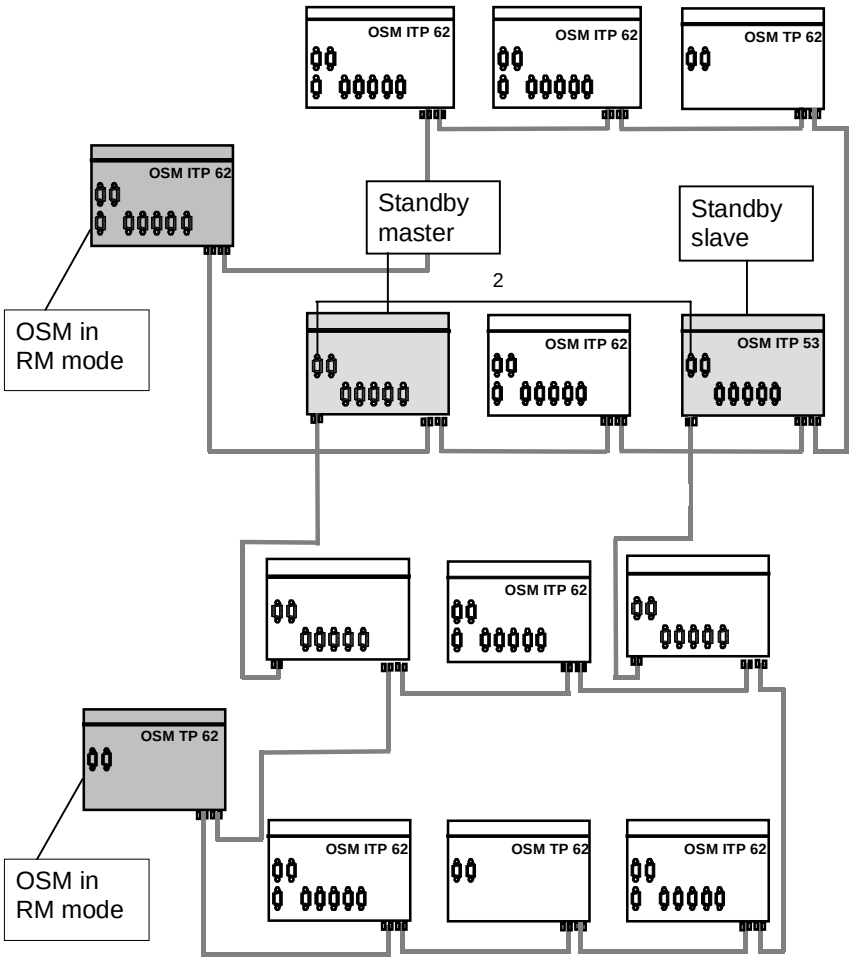
When replacing a standby master during operation, the following order is necessary to prevent an interruption on the network:

1. Remove the terminal block for the power supply on the standby master
2. Remove the signal lines and the standby connecting cable from the standby master.
3. Connect the signal lines to the standby connecting cable on the replacement device.
4. Plug in the terminal block for the power supply on the replacement device.

When replacing a standby slave, no special measures are necessary.

Redundant Coupling of Rings over Fiber Optic Cable with the OSM ITP53

The OSM ITP53 allows a redundant coupling of rings with FO transmission paths. This allows rings far apart from each to be connected.



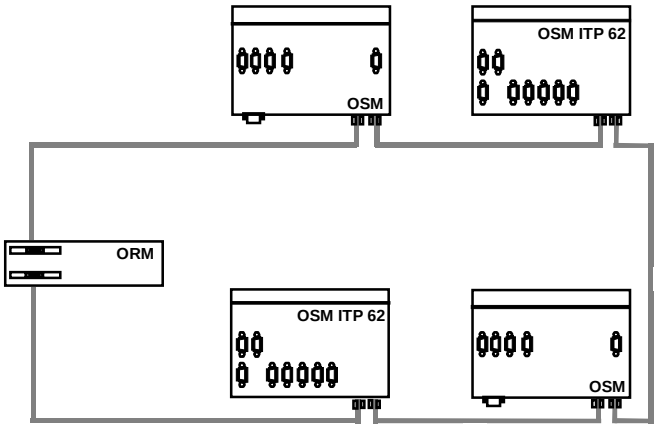
1 Fiber-optic cable (FO)
2 ITP XP standard cable 9/9

Figure 12: Redundant Coupling of Rings with OSM ITP 53

3.4 Compatibility of OSM Version 2/ESM with OSM/ORM Version 1

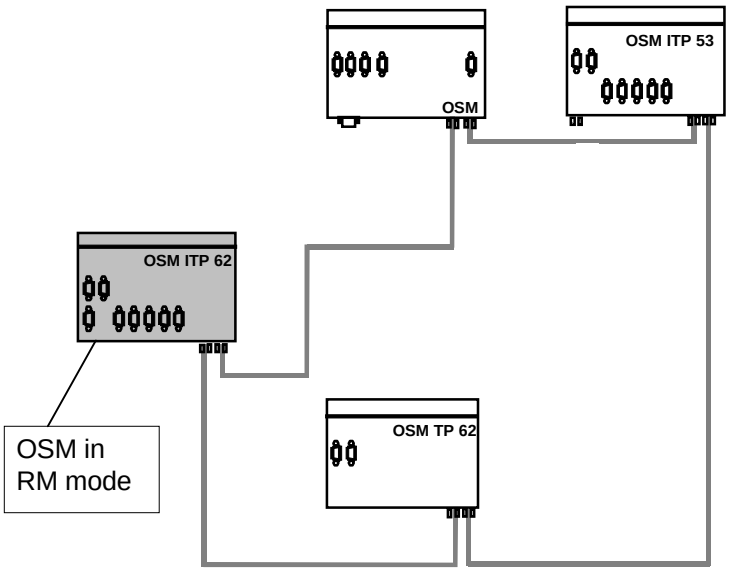
Compatibility

Version 2 OSMs can be operated at the same time in the ring with the OSM (6GK 1105-0AA00) and ORM (6GK 1105-1AA00) here called OSM/ORM Version 1. Make sure that only one device can adopt the redundancy manager function in the ring; in other words, only one ORM or only one OSM Version 2 operating in the RM mode.



1 Fiber-optic cable (FO)

Figure 13: Ring with ORM as Redundancy Manager

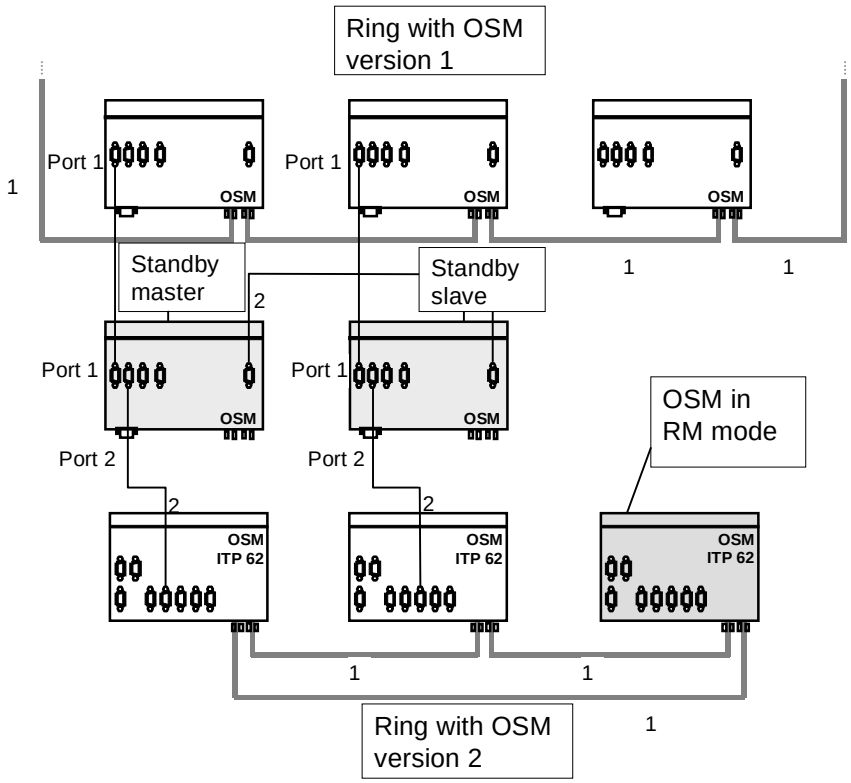


1 Fiber-optic cable (FO)

Figure 14: Ring with OSM Version 2 as Redundancy Manager

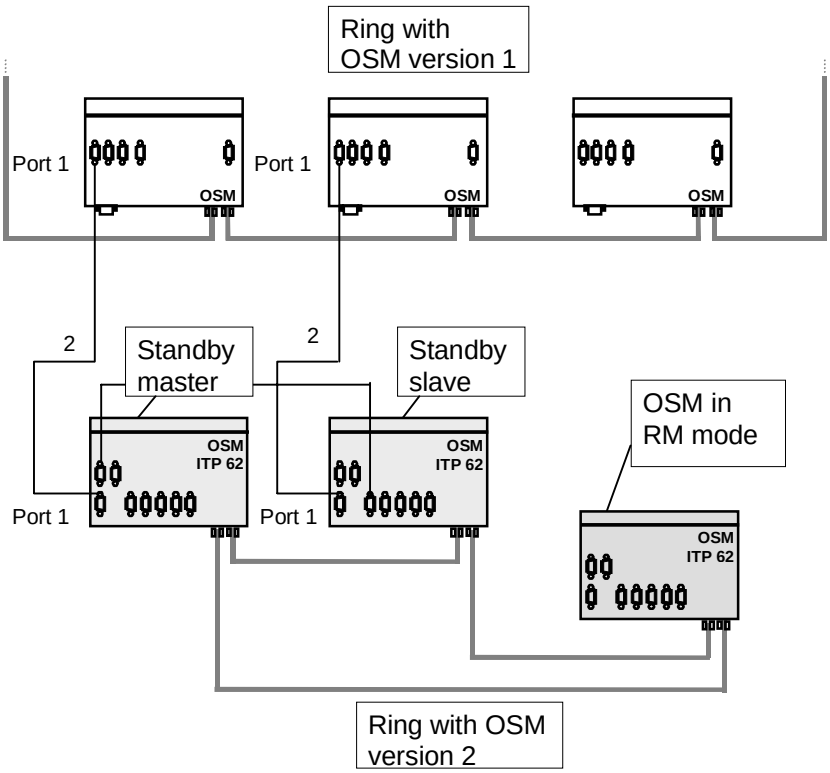
Redundant Coupling of Rings

In a redundant coupling of rings, make sure that the standby master and standby slave are either both of the type OSM Version 1 or both of the type OSM Version 2.



1 Fiber-optic cable (FO)
2 ITP XP standard cable 9/9

Figure 15: Redundant Ring Coupling with OSM V1 as Standby Master/Standby Slave



1 Fiber-optic cable (FO)
2 ITP XP standard cable 9/9

Figure 16: Redundant Ring Coupling with OSM V2 as Standby Master/Standby Slave

Figure 16 also shows how an existing ring with Version 1 OSMs can be connected to a ring with Version 2 OSMs.

3.5 Coupling Network Segments

A network segment can be connected to each of the ports of an OSM/ESM.

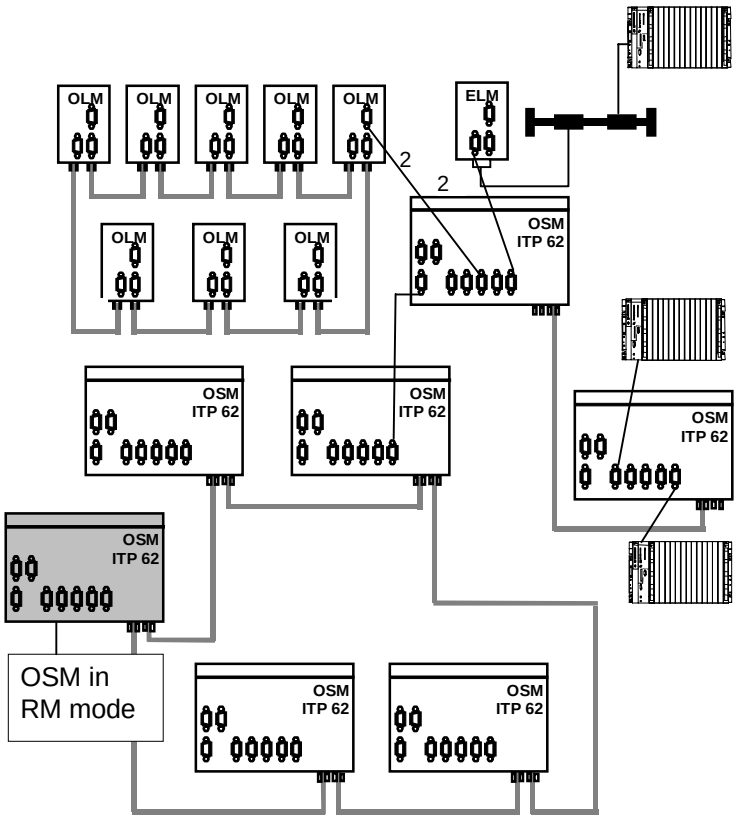
The Ethernet Planning Rules:

- Sum of the delay equivalents and cable lengths in the worst-case path shorter than 4520 m.
- Sum of the variability values in the worst-case path less than 50 bit times

need only be maintained as previously in each individual segment (see also "SIMATIC NET Industrial Twisted Pair and Fiber Optic Networks" manual).

The coupling of network segments via OSM has further advantages:

- The collision domain ends at the OSM ports and the network segments attached to them, the permitted total network span increases.
- Only valid data packets are passed on via OSM ports. Network segments with problems cannot influence other network segments.
- Data packets are only passed on to the ports to which the DTE with the destination address is connected. The available transmission capacity increases since the local data traffic of a network segment no longer puts load on another network segment.



1 Fiber-optic cable (FO)
2 ITP XP standard cable 9/9

Figure 17: Coupling Network Segments

Interfaces, Displays and Operator Controls

4

4.1 ITP/TP Ports

This chapter describes the properties of ITP and the TP ports.

4.1.1 ITP Ports

In the ITP variant of the OSM/ESM, the DTEs are attached via sub-D female connectors. The casings of the connectors are electrically connected to the casing of the OSM. A screw locking mechanism holds the connectors firmly in place.

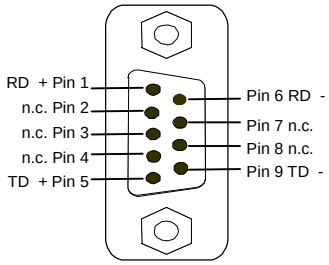


Figure 18: Pinout

4.1.2 TP Ports

With the OSM TP62 and ESM TP80, the DTEs are attached via RJ-45 female connectors.

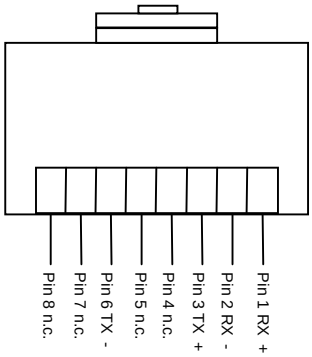


Figure 19: Pinout

4.1.3 Properties of the TP/ITP Ports

Link Control

OSMs/ESMs monitor the connected TP/ITP cable segments for short-circuits or wire breaks using regular link test pulses complying with the 100BASE-TX standard. OSMs/ESMs do not send data to a segment from which they are not receiving link test pulses. An unused interface is taken to be a wire break since the device without power cannot send link test pulses.

Auto Polarity Exchange

If the receive cable pair is incorrectly connected (RD+ and RD- swapped over), the polarity is automatically reversed.

Auto-negotiation Mode

The TP/ITP ports of OSM/ESM are set to the auto-negotiation mode.

They automatically detect the transmission rate (10 or 100 Mbps) at which the attached device or attached network segment operates and set themselves to this rate. If the partner device also supports the auto-negotiation mode, the devices further negotiate whether they will exchange data with each other in the half duplex or full duplex mode.

Note

If the partner device connected to a port of an OSM/ESM does not support the auto-negotiation mode (for example OSM Version 1), the port of the partner device must be set to half duplex mode.

4.1.4 FO Ports

The FO ports have BFOC/2.5(ST) female connectors. They monitor the connected cable for wire breaks complying with the IEEE 802.3 100 Base-FX standard. A break on the FO cable is always signaled by the port status display of both connected OSMs. (Status LED of the port goes off).

4.1.5 Standby Sync Port

A 9-pin female connector is used to connect the ITP XP Standard Cable 9/9 for the redundant standby coupling. The casing of the connector is electrically connected to the casing of the OSM/ESM.

A screw locking mechanism holds the connectors firmly in place.

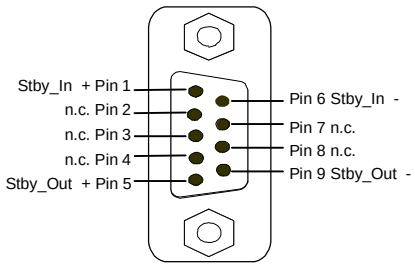


Figure 20: Pinout

4.1.6 Serial Interface

OSMs/ESMs have an RS-232 interface that is used for firmware updates.

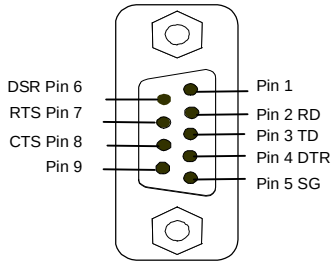


Figure 21: Pinout

4.1.7 Signaling Contact/Terminal Block for Attaching the Power Supply

The attachment of the power supply and the signaling contact is made using a 6-pin plug-in terminal block with a screw locking mechanism.

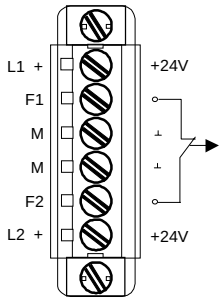


Figure 22: Terminal Block

Warning

Industrial Ethernet OSMs/ESMs are designed for operation with safety extra-low voltage. This means that only safety extra-low voltages (SELV) complying with IEC950/EN60950/ VDE0805 can be connected to the power supply terminals and the signaling contact.

The power supply unit to supply the OSM/ESM must comply with NEC Class 2 (voltage range 18 - 32 V, current requirement 1 A)

The signaling contact can carry a load of maximum 100 mA (safety extra-low voltage (SELV), DC 24V).

Power Supply

The power supply can be connected redundantly. Both inputs are isolated. There is no load distribution. With redundant power supply, the power supply unit with the higher output voltage supplies the OSM/ESM alone. The power supply voltage is electrically isolated from the casing.

Signaling Contact

The following is signaled via a floating signaling contact (relay contact) when contact is broken:

- The failure of a monitored power supply. Which power supply is monitored is specified in the fault mask (see Section 4.2.3).
- The incorrect link status of a monitored port (in other words, the port is not correctly attached or there are no link test pulses coming from the partner device). The ports to be monitored are selected using the fault mask.
- When at least one port is segmented.

In the RM Mode (additional)

- The incorrect link status of port 7 or port 8 depending on the status of the fault mask.
- When a second OSM is switched to the RM mode in the same ring.

OSM/ESM in Normal Mode and ITP XP Standard Cable 9/9 Plugged into the Standby Sync Port:

- Short-circuited ITP XP Standard Cable 9/9
- Bad standby configuration: The partner device connected via the ITP XP Standard Cable 9/9 is not switched to standby.
- If there is an incorrect link status on a standby port.

OSM/ESM in the Standby Mode:

- ITP XP Standard Cable 9/9 not plugged in, short-circuited or broken
- Bad standby configuration: The partner device connected via the ITP XP Standard Cable 9/9 is switched to standby.
- If there is an incorrect link status on a standby port.

4.2 Displays and Operator Controls

The OSM/**ESM** has the following LED displays:

4.2.1 LED "Status"

The status display indicates the operating mode of an OSM/ESM:

Fault (red LED):

Status	Meaning
Lit	The OSM/ESM has detected an error. The signaling contact opens at the same time. The signaled errors are described in Chapter 4.1.7.
Not lit	No errors detected by the OSM/ESM.

Stby – Standby (green LED):

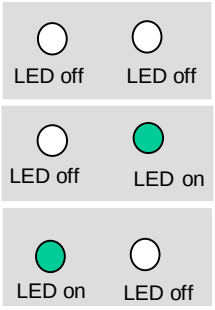
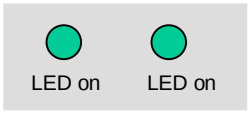
Status	Meaning
Lit	The standby function is activated, the OSM/ESM is in the standby passive mode.
Not lit	The standby function is deactivated.
Flashes	The standby function is activated, OSM/ESM is in the standby active mode; in other words, the master OSM/ESM has failed and the standby OSM/ESM takes over data traffic.

RM – Redundancy Manager (green LED)

Status	Meaning
Lit	The OSM/ESM is operating in the redundancy manager mode. The ring is operating free of errors in other words the redundancy manager does not allow traffic through but monitors the ring. Note: One OSM must operate in the redundancy manager mode (and one only) in each OSM/ESM ring.
Not lit	The OSM/ESM is not in the redundancy manager mode.
Flashes	The OSM/ESM is in the redundancy manager mode and has detected a break on the ring. The OSM/ESM makes the connection between its two ring ports so that a functional bus configuration is reestablished.

4.2.2 LED "Power"

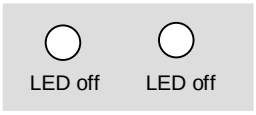
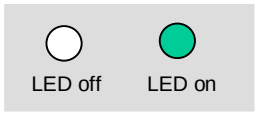
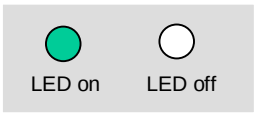
The display mode of the "Power" LED can be switched over by briefly pressing the "Select/Set" button on the front panel of the OSM/ESM. The valid display mode is indicated by the two display mode LEDs on the OSM/ESM.
Depending on the status of the two display LEDs, the "Power" LED has the two following display modes:

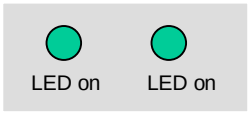
Display mode	Meaning
Status of the power supplies In the following states of the **display mode LEDs**, the **Power LEDs** indicate the current status of the two voltages of the OSM/ESM: Display Mode  	**Power LED L1 or L2** - Lit green; in other words, power supply 1 or 2 (line 1 or line 2) is applied. - Not lit; in other words power supply 1 or 2 (line 1 or line 2) is less than 14 V.
Fault Mask Display  	With the line 1 or 2 LEDs, the fault mask indicates whether the power supplies are monitored with the signaling contact. **L1 or L2 LED** - Lit green; in other words the corresponding power supply (line 1 or line 2) is monitored. If the power supply falls below 14 V, the signaling contact responds. - Not lit, in other words the corresponding power supply (line 1 or line 2) in not monitored. If the power supply falls below 14 V this does not trigger the signaling contact. The fault mask can be set again with the button on the front panel of the OSM/ESM (see 4.2.4.2)

The "Select/Set" button on the front panel of the OSM/ESM changes the display mode of the display LEDs. Using this button, a new status can be programmed for the fault mask (see 4.2.4.2)

4.2.3 Port LEDs

The port LEDs indicate the operating states of the individual ports of the OSM/ESM. The display mode of the port LEDs can be changed using the button on the front panel of the OSM/ESM allowing all operating states to be displayed. The current display mode is signaled by the two display mode LEDs.

Display mode	Meaning
Port Status Display  	**Port LED** - Not lit: No valid connection to the port (for example station turned off or cable not connected) - Lit green: Valid connection - Flashes green (once per period): Port switched to standby - Flashes green (twice per period): Port is segmented - Flashes green (three times per period): Port is turned off - Flashes/lit yellow: Data reception on this port
100 Mbps Display  	**Port LED** - Lit green: Port operating at 100 Mbps - Not lit: Port operating at 10 Mbps
Full duplex Display  	**Port LED** - Lit green: Port operating in full duplex mode - Not lit: Port operating in half duplex mode

Display mode	Meaning
Fault mask Display  	The fault mask indicates whether the ports and the power supplies are monitored with the signaling contact. **Port LED** - Lit green: Port is monitored; in other words, if the port does not have a valid connection (for example cable not plugged in or attached device turned off), the signaling contact is triggered. - Not lit: The port is not monitored; in other words, an invalid or valid connection at the port does not trigger the signaling contact. The fault mask can be set again with the button on the front panel of the OSM (see 4.2.4.2)

The basic status "Port Status" of the display is adopted automatically after turning on the device. The device also switches automatically to this display status when the "Select/Set" button is pressed for more than a minute.

4.2.4 Operator Controls

4.2.4.1 Two-Pin DIP Switch

With the two-pin DIP switches on the upper casing of the OSM/ESM you can do the following:

- With the **Stby** button, you can toggle the standby function on and off.
- With the **RM** switch, you can activate the redundancy manager function.

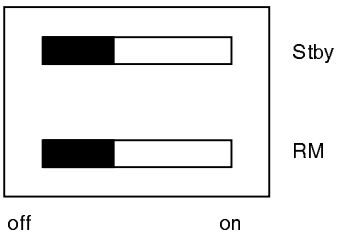


Figure 23: DIP Switches

4.2.4.2 "Select/Set" Button

The "Select/Set" button on the front panel of the OSM/ESM has the following functions:

- Pressing the button briefly moves on the display of the port LEDs (display mode). The current display mode is indicated by the display mode LEDs.
- If the display is in the port status (both display mode LEDs off) and if the button is pressed for three seconds, the display mode LEDs begin to flash. If you then continue to press the button for a further two seconds, the OSM/ESM is reset.

When it is reset, all the settings of the OSM/ESM are set to their defaults (as set in the factory). This allows you to cancel settings made, for example, with Web-Based Management (WBM) (see also OSM/ESM Network Management, User Manual).

- If the display is in the fault mask status and you press the button for two seconds, the display LEDs start to flash. If you then press the button for a further two seconds, the current status of the ports and the supply voltages are entered in the fault mask. This means, if, for example, the ports 1, 5, 6 had a valid connection (in other words the port status displays of these ports are lit green or yellow) and if power supply 1 was active at the point when the values were entered in the fault mask, ports 1, 5, 6 and power supply 1 will then be monitored.

Note

If the "Select/Set" button is pressed while the device is starting up (takes approximately 20 seconds) after turning on the OSM/ESM, the OSM/ESM changes to the load firmware status (both display mode LEDs flash simultaneously). This status is exited by pressing the button again. For further information on loading the firmware, refer to Chapter 6.

Installation, Commissioning, Cleaning and Maintenance

5

5.1 Unpacking, Checking the Consignment

1. Check that the consignment includes the following components:
   - OSM/ESM device
   - Mounting angles, screws and terminal block
   - CD (includes the manuals) and product information bulletin
2. Check each component for any damage.

Warning
Do not install damaged components!

5.2 Installation

OSMs/ESMs can be installed in several ways:

- Installation on a 35 mm standard rail
- Installation on a SIMATIC S7-300 rail
- Installation in pairs in a 19" cubicle
- Wall mounted

Note

Remember that the OSM/ESM must only be installed horizontally (ventilation slits top/bottom see Figure 25). To ensure adequate convection, there must be a clearance of at least 5 cm above and below the ventilation slits. You should also make sure that the permitted ambient temperature is not exceeded.

Preparations

1. Before installing, check whether the switch setting of the DIP switches is correct for your application (see Section 4.2.4.1)
2. Remove the terminal block from the OSM and wire up the powers supply and signal lines as described in Section 4.1.7.

Standard Rail Mounting

1. Install the OSM/ESM on a 35 mm standard rail complying with DIN EN 50022.
2. Fit the OSM/ESM on to the rail from above and press in the bottom of the device until the catch engages.
3. Fit the electrical and optical connecting cables, the terminal block for the power supply and, if necessary, the standard cable 9/9 to the standby sync port.

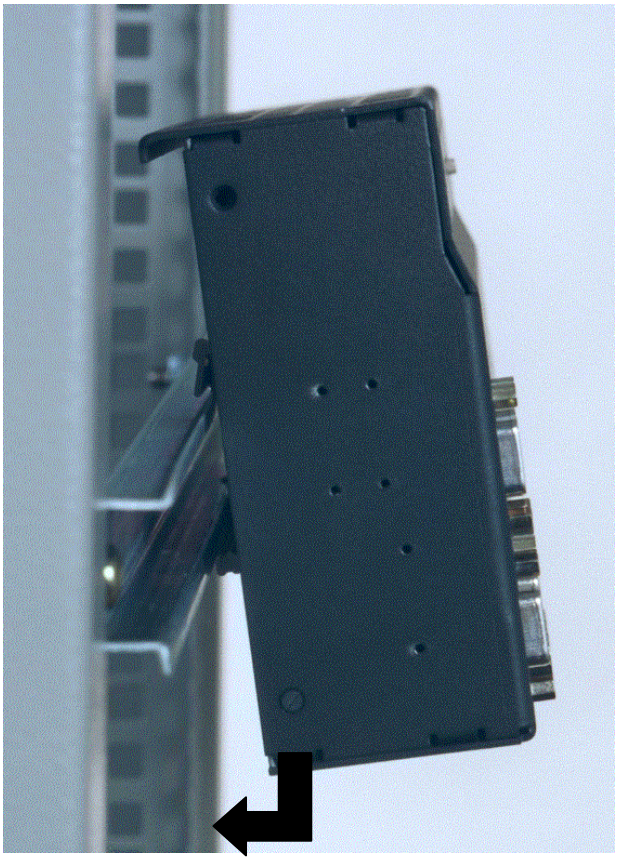


Figure 24: Installing the OSM on a DIN Standard Rail

Removing from a Standard Rail

1. To remove the OSM/ESM from the standard rail, pull the device down and then pull the bottom away from the standard rail.

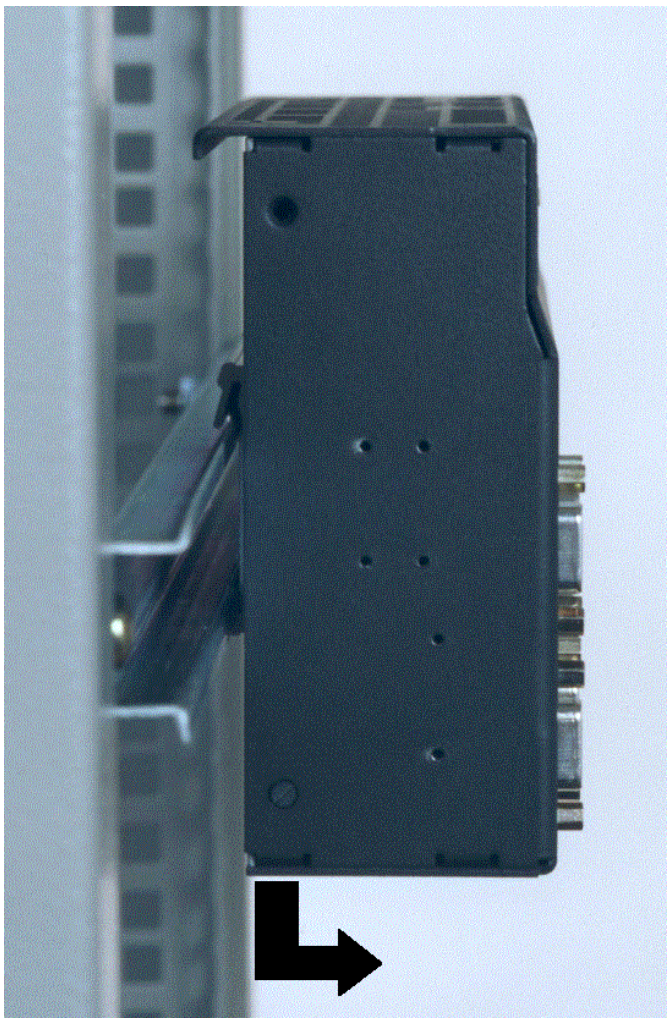


Figure 25. Removing from the Standard Rail

Installation on a SIMATIC S7-300 Rail

1. First secure the two supplied angles on both sides of the OSM/ESM.
2. Fit the guide on the top of the OSM casing into the S7 rail.
3. Secure the OSM/ESM with the supplied screws to the lower part of the rail.

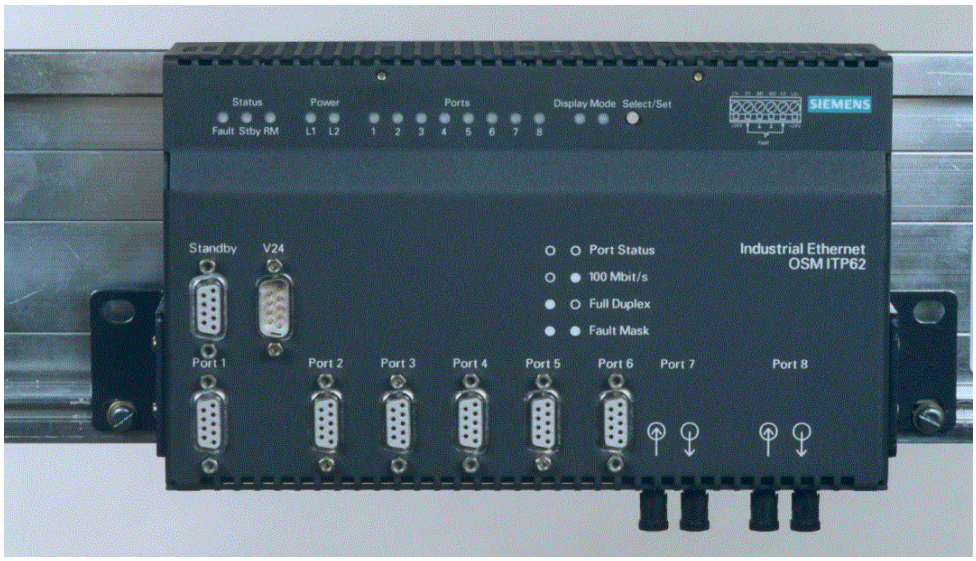


Figure 26: Installation on the S7-300 Rail

Installation in Pairs in the 19" Cubicle

To install in pairs in the 19" cubicle, you require the two securing angles supplied.

1. First screw the two OSMs/ESMs together using the supplied holding plate on the rear.

2. Fit two of the supplied angles to the sides

3. Secure the two devices using the angles in the 19" cubicle. Please note that the OSM/ESM must be grounded with a low resistance via the two holding angles.

Figure 27: Installation in the 19" Cubicle

Wall Mounting

To install an OSM/ESM on a wall, follow the steps below:

1. Fit the supplied mounting angles on the sides.
2. Secure the device to the wall using the angles.
3. Connect the device to protective earth with a low-resistance connection via one of the angles.

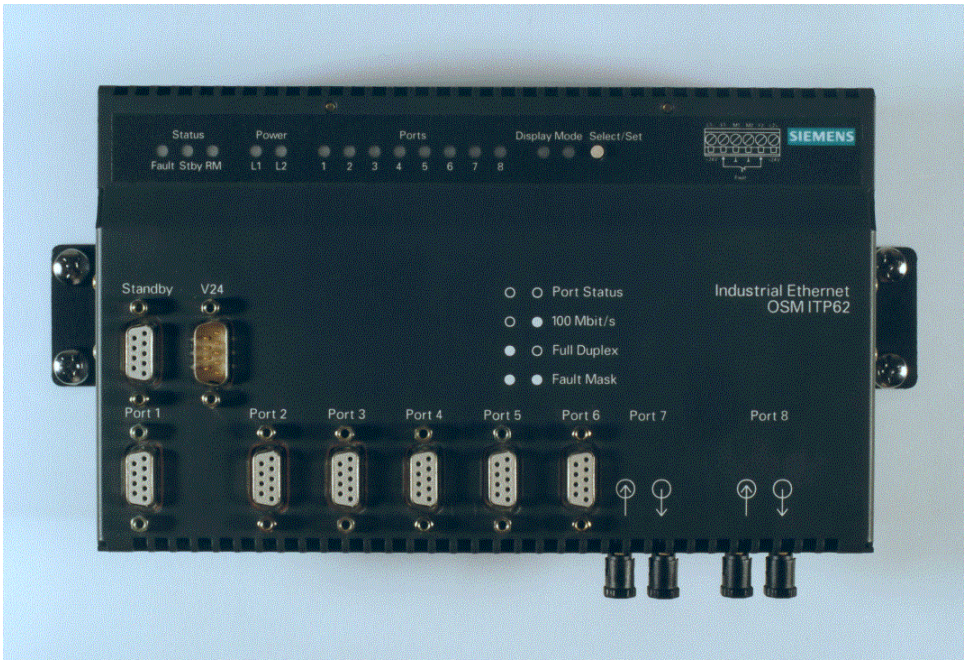


Figure 28: Wall Mounting

The following table shows how to mount the device on different types of walls:

Wall	Mounting
Concrete wall	Use four wall plugs 6 mm in diameter and 30 mm long. (drill hole 6 mm in diameter, 45 mm deep). Use screws 4.5 mm in diameter and 40 mm long.
Metal wall (min. 2 mm thick)	Use screws 4 mm in diameter and at least 15 mm long.
Sandwich type plaster wall (min. 15 mm thick)	Use an anchoring plug with at least 4 mm diameter.

Note

The module must be secured to the wall so that the mounting can carry at least four times the weight of the module.

5.3 Cleaning

If you need to clean the OSM/ESM, use a dry cloth only.

5.4 Maintenance

If a fault develops, please send the module to your SIEMENS service department for repair. The devices are not designed for repair on site.

Firmware Update

6

With the OSM/ESM it is possible to update the firmware via the serial port.

Information on firmware updates for OSM/ESM is available on the Internet at http://www.ad.siemens.de/csi/net.

To download the firmware you require a PC with Windows 95/98/NT and the Hyperterminal program available under Accessories. The download is explained below based on the dialogs displayed in Hyperterminal.

Preparations

Connect the serial port of your PC and the OSM/ESM with a normal null modem cable . Depending on the port of the PC that you are using, you require a cable with a 9-pin or 25-pin sub-D female connector for the PC end, and a 9-pin female connector for the OSM/ESM end.

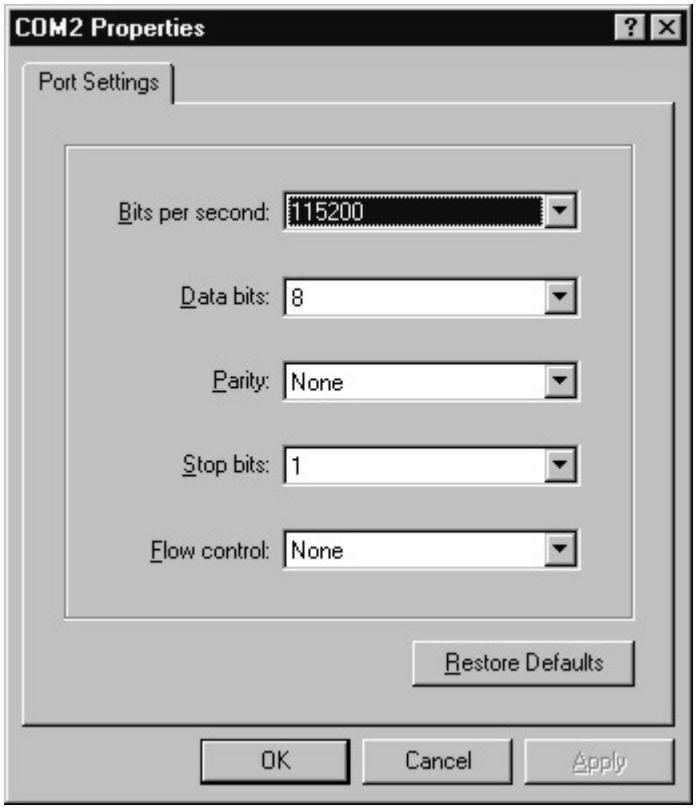
The following table shows the pinout and the connections for both types of cable:

PC port	25-pin Female	9-pin Female	connected to	OSM port 9-pin Female	
Signal Name	Pin	Pin	———	Pin	Signal name
TD (Transmit Data)	2	3	———	2	RD
RD (Receive Data)	3	2	———	3	TD
RTS (Request To Send)	4	7	———	8	CTS
CTS (Clear To Send)	5	8	———	7	RTS
SG (Signal Ground)	7	5	———	5	SG
DSR (Data Set Ready)	6	6	———	4	DTR
DTR (Data Terminal Ready)	20	4	———	6	DSR

Follow the steps outlined below in Hyperterminal:

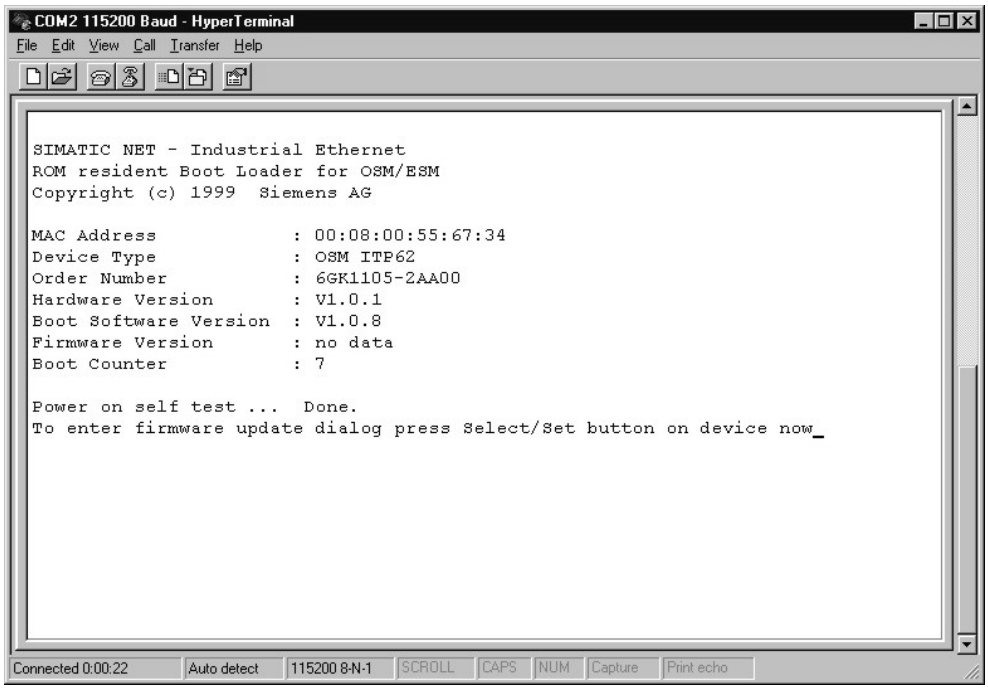
1. Set up a new connection (for example with File -> New).

2. Set the following properties for the connection as shown in the dialog below:



3. Reset the OSM/ESM. Press the Select/Set button during operation, if necessary several times until the display LEDs indicate the port status (both display LEDs off). Then press the Select/Set button for at least 6 seconds. The display LEDs begin to flash after approximately 3 seconds, 2 seconds later the OSM/ESM is reset. (All LEDs go on briefly and then off again).

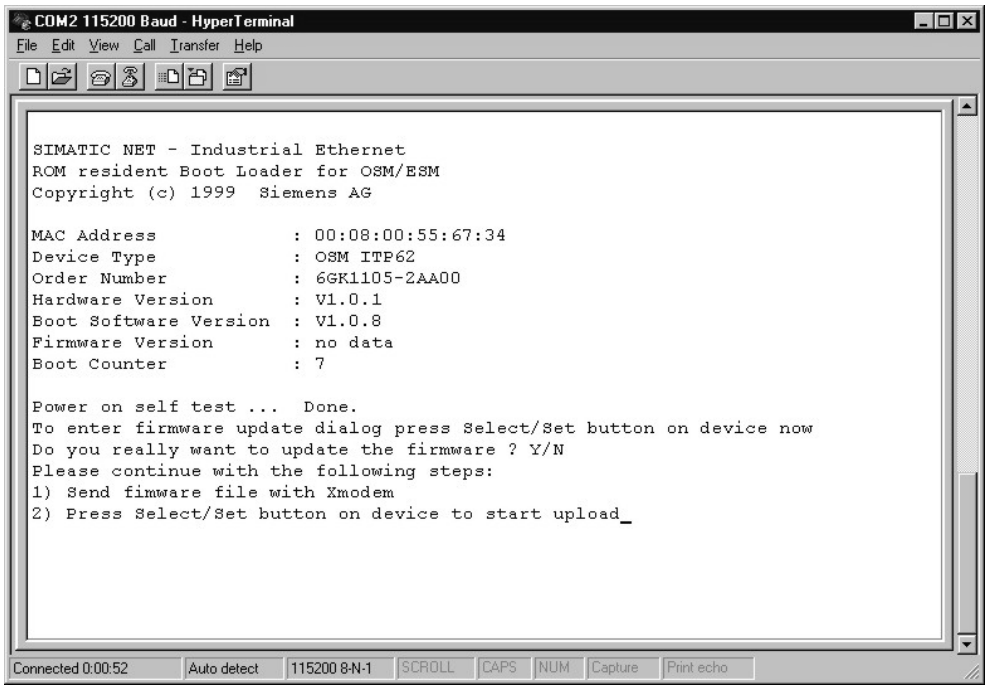
The following message then appears in the Hyperterminal window:


COM2 115200 Baud - HyperTerminal
File Edit View Call Transfer Help
SIMATIC NET - Industrial Ethernet
ROM resident Boot Loader for OSM/ESM
Copyright (c) 1999 Siemens AG
MAC Address : 00:08:00:55:67:34
Device Type : OSM ITP62
Order Number : 6GK1105-2AA00
Hardware Version : V1.0.1
Boot Software Version : V1.0.8
Firmware Version : no data
Boot Counter : 7
Power on self test ... Done.
To enter firmware update dialog press Select/Set button on device now_
Connected 0:00:22
Auto detect
115200 8-N-1
SCROLL
CAPS
NUM
Capture
Print echo

4. Press the "Select/Set" button again briefly

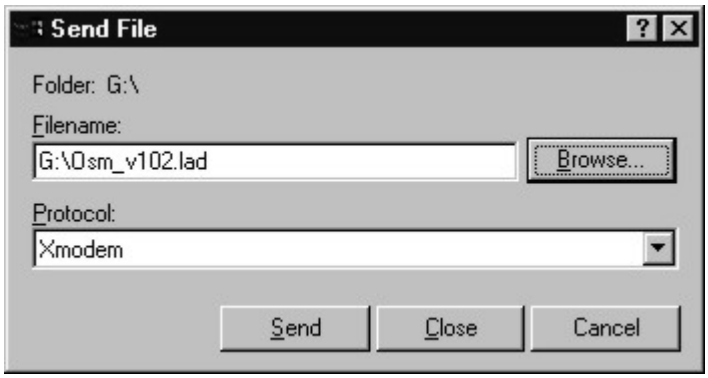
5. Then confirm the prompt: "Do you really want to update your firmware? Y/N" with Y.

The following message is then displayed.

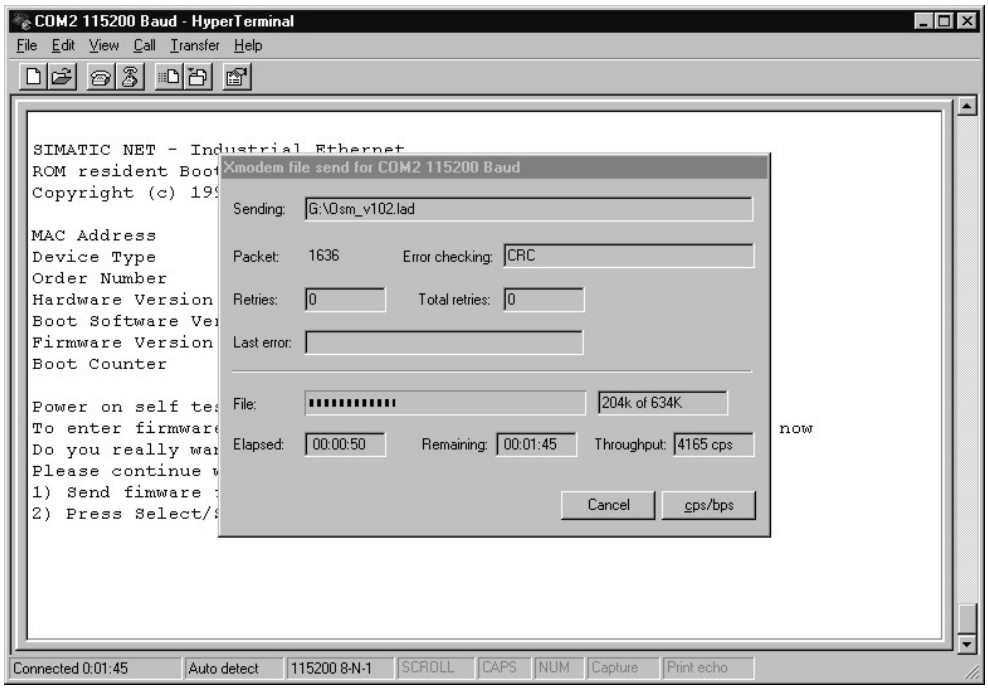

COM2 115200 Baud - HyperTerminal
File Edit View Call Transfer Help
SIMATIC NET - Industrial Ethernet
ROM resident Boot Loader for OSM/ESM
Copyright (c) 1999 Siemens AG
MAC Address : 00:08:00:55:67:34
Device Type : OSM ITP62
Order Number : 6GK1105-2AA00
Hardware Version : V1.0.1
Boot Software Version : V1.0.8
Firmware Version : no data
Boot Counter : 7
Power on self test ... Done.
To enter firmware update dialog press Select/Set button on device now
Do you really want to update the firmware ? Y/N
Please continue with the following steps:
1) Send fimware file with Xmodem
2) Press Select/Set button on device to start upload
Connected 0:00:52
Auto detect
115200 8-N-1
SCROLL
CAPS
NUM
Capture
Print echo

6. Now select the function Transfer > Send File function in the Hyperterminal window.

7. In the next dialog window, enter the file to be downloaded and select "Xmodem" as the protocol. Start the transfer of the firmware with the "Send" button.



The following dialog then appears displaying the progress of the download.



Downloading can take up to 10 minutes. After you have downloaded the firmware successfully, the device is automatically started with the new firmware. Please note the version of the new firmware on a label on the side labeling panel of the OSM/ESM.

Note

During the download, do not interrupt the connection between the PC and OSM/ESM or turn off the power supply to the OSM/ESM. If the firmware could not be downloaded completely to the OSM due to a power failure, the message "Firmware in flash is faulty" appears after the device starts up. This means that the firmware must be downloaded again.

Technical Specifications 7

Ports	
Attachment of DTEs or network segments twisted pair/Industrial Twisted Pair	6 x 9-pin sub-D female connector with OSM ITP62, OSM ITP62-LD 5 x 9-pin sub-D female connector with OSM ITP53 8 x 9-pin sub-D female connector with ESM ITP80 6 x RJ-45 female connector with OSM TP62 8 x RJ-45 female connector with ESM TP80 All electrical ports support 10/100 Mbps auto-negotiation
Standby sync port for redundant coupling of rings	1 x 9-pin sub-D female connector
Attachment of further OSMs and DTEs via FO	2 x 2 BFOC female connectors with OSM ITP 62, OSM ITP62-LD, OSM TP62 3 x 2 BFOC female connectors with OSM ITP 53 (100 Mbps, 100BaseFX, full duplex)
Connector for power supply and signaling contact	1 x 6-pin plug in terminal block
Power supply (redundant inputs isolated)	2 DC 24V infeeds (DC 18 to 32 V) Safety extra-low voltage (SELV)
Power loss at 24 V DC	20 W
Load on the signaling contact	DC 24 V / max. 100 mA safety extra-low voltage (SELV)
Current consumption at rated voltage	1000 mA
Overcurrent protection at input	Non-replaceable fuse (1.6 A / 250 V / slow)

Permitted Cable Lengths	
FO cable length between two OSMs	For OSM ITP62, OSM ITP53, OSM TP62: 0-3000 m (62.5/125 µm glass fiber; 1 dB/km at 1300 nm; 600 MHz*km; 6 dB max. permitted optical power loss with 3 dB link power margin) 0-300 m (50/125 µm glass fiber; 1 dB/km at 1300 nm; 600 MHz*km; 6 dB max. permitted optical power loss with 3 dB link power margin) For OSM ITP62-LD 0-26000 m (10/125 µm monomode fiber; 0.5 dB/km at 1300 nm; 13 dB max. permitted optical power loss with 2 dB link power margin)
ITP cable length	0-100 m
TP cable length	0-10 m with TP cord Up to 100 m total length when using structured cabling
Length of the ITP XP Standard Cable 9/9 at standby sync port	0-40 m

Cascading Depth	
Bus/star structure	Any (only depending on signal propagation time)
Redundant ring	50 (for reconfiguration time < 0.3 s)

Switching Properties of OSM/ESM	
Number of learnable addresses	Up to 12000
Aging time	40s (Default)
Latency	4 µs (measured at 75% load between two ports operating at 100 Mbps)
Switching procedure	Store and forward

Permitted Ambient Conditions/EMC	
Operating temperature	0°C to +60°C (exception: OSM ITP 62-LD with 0°C to 55°C)
Storage/transport temperature	-40°C to +80°C
Relative humidity in operation	‹ 95% (no condensation)
Operating altitude	Max. 2000 m
Noise emission	EN 55081 Class A
Noise immunity	EN 50082-2
Laserprotection	Class 1 comply with IEC 60825-1

Mechanical Design	
Dimensions (W x H x D) in mm	217 x 136.5 x 69
Weight in g	1400
Installation options	Standard rail S7-300 rail Wall mounted Installation in 19" cubicle **Only horizontal installation permitted (ventilation slits top/bottom)**
Degree of protection	IP 20

Consignment / Order Numbers	
Consignment	- SIMATIC NET Industrial Ethernet OSM/ESM including terminal block for power supply - Fittings for 19" cubicle installation/wall mounting - 6-pin plug in terminal block - Operating Instructions - Reply form
Order numbers:	
Industrial Ethernet OSM	6GK1105-2AA00
ITP 62 Industrial Ethernet OSM ITP 62-LD	6GK1105-2AC00
Industrial Ethernet OSM ITP 53	6GK1105-2AD00
Industrial Ethernet ESM ITP 80	6GK1105-3AA00
Industrial Ethernet OSM TP 62	6GK1105-2AB00
Industrial Ethernet ESM TP 80	6GK1105-3AB00

Accessories	
Industrial Twisted Pair and Fiber Optic Networks Manual	6GK1970-1BA10-0AA0
Triaxial networks for Industrial Ethernet manual	6GK1970-1AA20-0AA0

Further Support

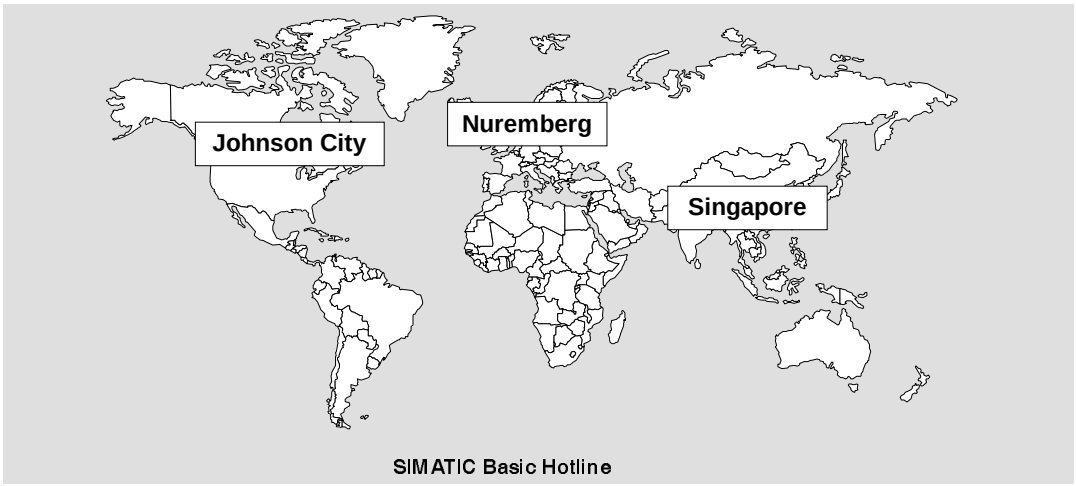
8

Further Support

If you have other questions on SIMATIC NET products, please contact your local Siemens office or representative. You will find the addresses in the SIMATIC NET Catalog IKPI or on the Internet at http://www.ad.siemens.de/net.

SIMATIC Customer Support Hotline

Available at all times worldwide:



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In its online services, SIMATIC Customer Support provides you with wide-ranging additional information about SIMATIC products:

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SIMATIC Training Center

To help you to become familiar with working with SIMATIC S7 PLCs, we offer a range of courses. Please contact your regional training center or the central training center in D-90327 Nuremberg, Tel. +49-911-895-3154.

Notes on the CE Mark

9

Product name:

SIMATIC NET	OSM ITP 62	6GK 1105-2AA00
	OSM ITP 62-LD	6GK 1105-2AC00
	OSM ITP 53	6GK 1105-2AD00
	ESM ITP 80	6GK 1105-3AA00
	OSM TP 62	6GK 1105-2AB00
	ESM TP 80	6GK 1105-3AB00

The SIMATIC NET products listed above meet the requirements of the following EU directives:

EMC Directive

Directive 89/336/EEC “Electromagnetic Compatibility"

Area of Application

The products are designed for use in an industrial environment:

Area of Application	Requirements	
	Emitted Noise	Noise immunity
Industry	EN 50081-2 : 1993	EN 50082-2 : 1995

Adherence to Installation Instructions

The products meet the requirements if you adhere to the installation and safety instructions contained in this documentation (Description and Operating Instructions for Industrial Ethernet OSM/ESM (Version 2)) and in the following documentation during installation and operation:

- SIMATIC NET Industrial Twisted Pair and Fiber Optic Networks Manual
- SIMATIC NET Triaxial Networks for Industrial Ethernet

Declaration of Conformity

The EU declaration of conformity is available for the responsible authorities according to the above-mentioned EU directive at the following address:

Siemens Aktiengesellschaft

Bereich Automatisierungs- und Antriebstechnik

Industrielle Kommunikation (A&D PT2)

Postfach 4848

D-90327 Nürnberg

Notes for the Manufacturers of Machines

This product is not a machine in the sense of the EU directive on machines. There is therefore no declaration of conformity for the EU directive on machines 89/392/EEC.

If the product is part of the equipment of a machine, it must be included in the procedure for obtaining the declaration of conformity by the manufacture of the machine.

Glossary

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Auto Polarity Exchange
Procedure in which the module automatically detects incorrect attachment of a cable to the electrical OSM/ESM port (RD+ and RD- swapped over). The OSM then reverses the polarity automatically.

Auto-Negotiation
Procedure standardized by IEEE 802.3 in which the transmission parameters (for example 10/100 Mbps, full/half duplex) are negotiated automatically between the devices.

Autosensing
See Auto-Negotiation

Backbone
In conjunction with the OSM/ESM, this means a bus or ring structure made up of interconnected OSM or ESM modules that form the backbone of an industrial LAN.

Display Mode
The two display mode LEDs indicate the display mode of the Port and Power LEDs of the OSM/ESM. The display mode can be changed with the button on the front panel of the OSM.

ESM
Electrical Switching Module. SIMATIC NET Ethernet switch with electrical ports

Fault Mask
See fault mask

Fault Mask
The fault mask specifies which ports (ports 1 - 8) and power supply terminals (line 1/2) are monitored by the signaling contact. The fault mask can be set again with the button on the front panel of the OSM/ESM.

Filtering
OSMs/ESMs learn the addresses of the devices that can be accessed via a port. They redirect the packets intended for this device only via this port.

ITP Port Port with Industrial Twisted Pair (ITP) connector (sub D 9-pin female)

Latency The latency specifies the taken for packets to pass through the OSM/ESM. It is assumed that a received packet can be sent on immediately. The latency does not include the time necessary for the OSM/ESM to receive a packet.

Link Control OSMs/ESMs monitor the connected TP/ITP cable segments for short-circuits or wire breaks using regular link test pulses complying with the 100BASE-TX standard. OSMs/ESMs do not send data to a segment from which they are not receiving link test pulses. An unused interface is taken to be a wire break since the device without power cannot send link test pulses.

OSM Optical Switching Module. SIMATIC NET Ethernet switch with optical and electrical ports

Reconfiguration Time Time required by the OSM/ESM operating in the redundancy manager (RM) or standby mode to reestablish a functioning configuration if a device fails or the cable is interrupted.

Redundancy Manager (RM) Mode of an OSM or ESM for forming a redundant ring structure. The RM monitors the OSM or ESM bus connected to it, closes the bus if it detects and interruption. This reestablishes a functioning bus configuration.

One and only one device can operate in the RM mode in every OSM or ESM ring.

Signaling Contact Floating relay contact via which the error states detected by the OSM/ESM can be signaled.

Standby Sync Port Port of an OSM/ESM via which the two OSMs or ESMs are connected in a redundant coupling to inform each other of their operating states.

Store and forward In this switching method used on the OSM/ESM, the complete packet is read in before it is passed on by the switch. A packet is only passed on if it is error-free.

TP Port Port with a TP connector (RJ-45 female)

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Glossary

10BASE2

Standard for 10 Mbps Ethernet transmission on thin coaxial cables (Cheapernet); maximum segment length 185 Meters

10BASE5

Standard for 10 Mbps Ethernet transmission on coaxial cables (Yellow Cable); maximum segment length 500 Meters

10BASE-FL

Standard for 10 Mbps Ethernet transmission on glass fiber-optic cables (Fiber Link)

10BASE-T

Standard for 10 Mbps Ethernet transmission on Twisted Pair cables

100BASE-T

Fast Ethernet Standard (100 Mbps) for data transmission on Twisted Pair cables

100BASEF-FL

Fast Ethernet Standard for data transmission on glass fiber-optic cables

Autonegotiation

Configuration protocol in Fast Ethernet
Devices on the network negotiate a transmission mode that each device is capable of using (100 Mbps or 10 Mbps; Full Duplex or Half Duplex) prior to the actual data transfer.

Autosensing

Capability of a device to detect the data rate (10 Mbps or 100 Mbps) automatically and to send/receive at this rate.

Backbone

The network at the highest level of a hierarchically structured plant network.

Bandwidth length product (FO)

Measure of the capability of a fiber-optic cable to transfer at high data rates.

Bridge

A network component that interconnects network segments. This ensures that local data traffic remains local, in other words only data packets for a node in the other segment are forwarded through the bridge. Errors in a network segment are restricted to the original network segment. In contrast to switches, bridges can only forward one data stream at any one time.

Burst

Temporarily increased network load due to data burst or a sudden flurry of signals

Bus

Common transmission path on which all nodes are connected; it has two defined ends.
In Industrial Ethernet, the bus takes the form of a segment with triaxial cable and transceivers.

Bus segment

 Segment

Bus system

All stations that are physically connected via a bus cable form a bus system.

Category x component

Cabling components are divided into various categories based on their transmission characteristics. Each of the categories has different physical limit values (for example maximum signal attenuation at a defined transmission frequency).
Category 3: Data transmission up to 16 MHz
Category 4: Data transmission up to 20 MHz
Category 5: Data transmission up to 100 MHz
Category 6: Data transmission up to 200 MHz

ITP standard cable and TP cord are category 5 components and suitable for transmission rates of 10 Mbps and 100 Mbps.

Chassis ground

Chassis ground includes all the interconnected inactive parts of equipment that must not have a hazardous voltage even in the event of a fault.

Collision domain

To ensure that the CSMA/CD protocol functions correctly, the propagation time of a data packet from one node to another is restricted.
This propagation time results in a specially limited span for the network depending on the data rate known as the collision domain. In 10 Mbps Ethernet, this is 4520 m and in Fast Ethernet it is 412 m.
Several collision domains can be connected together using bridges/switches.

CSMA/CD

Carrier Sense Multiple Access / Collision Detection
Ethernet medium access procedure

D.C. loop resistance

Total resistance of the outward and return line of a cable.

Delay equivalent

The delay equivalent describes the signal delay of a network component in the signal path. The value of the signal delay is specified in meters instead of seconds.
The value in meters corresponds to the distance that a signal could propagate within the time if the signal propagated through a cable rather than passing through the component.

Electromagnetic compatibility

Electromagnetic compatibility (EMC) deals with all questions of electrical, magnetic and electromagnetic emission and immunity and the functional disturbances in electrical devices resulting from these effects.

FDX

–> Full duplex

Fiber-optic cable (FO)

A fiber-optic cable is a transmission medium in an optical network. Only multimode glass fiber-optic cables are suitable for connecting optical Industrial Ethernet components.

Filtering

A switch filters data traffic based on source and destination addresses in a data packet. A data packet is passed on by the switch only to the port to which the addressee is connected.

FO

See fiber-optic cable

Full duplex

Capability of a device to transmit and receive data simultaneously. In the Full Duplex mode, collision detection is deactivated.

Ground

Ground is the conductive ground area whose potential at any point can be taken as zero.

Grounding

Grounding means connecting a conductive part to ground via a grounding system.

Half duplex

A device can either receive or transmit data at any one time.

HDX

–> Half duplex

Hub

Active network component with repeater functionality, synonym for star coupler

IEEE 802

Institute of Electrical and Electronics Engineers
LAN/MAN Standards Committee

IEEE 802.3

Institute of Electrical and Electronics Engineers
Ethernet working group

IEEE 802.3u

Institute of Electrical and Electronics Engineers
Fast Ethernet working group

IP 20

Degree of protection complying with DIN 40050: Protection against touching with fingers and against the penetration of solid foreign bodies with more than 12 mm ∅.

ITP

Industrial Twisted Pair; bus system based on the Twisted Pair standards IEEE 802.3i: 10BASE-T and IEEE 802.3j: 100BASE-TX for industrial application.

ITP standard cable

A twisted pair cable for industrial application complying with Category 5 with a particularly dense shield.

Load containment

Due to its filtering function, a bridge or switch ensures that local data traffic remains local. The local network load of a segment is contained in the originating segment and does not represent extra load on the remainder of the network.

Link Class

The link class describes the quality of a complete link from the active component to the DTE (patch cord, patch panel, installation cable, telecommunication outlet, connecting cable). This link must meet the value specified in the structured cabling standard ISO/IEC 1180.
In contrast to this, there is also the specification regarding ”categories”, where only requirements of products are defined, for example cable according to Category 5. The suitable interaction of components of a link is ignored.

MAN

Metropolitan Area Network
Data network with the geographical span of a city or town

Medium redundancy

Redundancy in the network infrastructure (cables and active components such as OLMs or OSMs/ORM)

NIC

Network interface card

OLM

Optical Link Module
Industrial Ethernet network component with repeater functionality

Optical power budget (FO)

This is available between a sender and receiver on a fiber-optic link. It indicates the difference between the optical power coupled in to a particular fiber by the optical transmitter and the input power required by an optical receiver for reliable signal detection.

Optical power loss (FO)

The optical power loss is the cumulative value of all the losses occurring in the fiber-optic transmission path. These are due mainly to the attenuation of the fiber itself and the splices and couplings. The optical power loss must be less than the optical power budget available between the transmitter and receiver.

ORM

Optical Redundancy Manager
Controls medium redundancy in an OSM ring

OSM

Optical Switch Module
Industrial Ethernet network component with switch functionality

Path Variability Value (PVV)

The variability value of a component describes the fluctuations in the propagation time of a data packet through a network component. The path variability value is the sum of all the fluctuations through all the network components between two nodes.

Redundancy

This means that standby equipment exists that is not required for the basic functioning of a system. If equipment fails, the standby can take over its function.
Example:
Medium redundancy:
An additional link closes the bus to form a ring. If there is a failure on part of the bus, the redundant link is activated to maintain the functionality of the network.

Reference potential

The voltages of circuits are considered and/or measured relative to this potential.

RJ-45

Connector for data lines also known as the Western plug. Commonly used connector in telephone and ISDN systems. This connector is also used in LAN installations in offices.

Router

Active network component that controls data traffic based on the IP address. Routers have a wide range of filtering and data management functions.

Segment

In triaxial networks, the transceivers connected together via 727-0 LAN cables and the nodes connected by 727-1 drop cables form a segment.
Several such segments can be connected via repeaters.
When using twisted pair and fiber-optic cables, each subsection forms a segment.

Segmentation

Disconnection of a faulty segment from an Ethernet network. With this function, network components such as OLMs, ELMs, ASGEs are capable of limiting faults to a segment.

Shared LAN

All components in a shared LAN operate at the nominal data rate. Shared LANs are structured with repeaters/hubs.

Shield impedance

Resistance to alternating current of the cable shield. Shield impedance is a characteristic of the cable used and is normally specified by the manufacturer.

Signal propagation time

The time required by a data packet to on its way through the network.

Spanning Tree Protocol

Configuration protocol for bridges specified in the IEEE 802.1d standard. Different ports in the bridges are switched to standby in meshed bridge structures to prevent data packets from circulating in the network. The result is a network with a tree structure. The standby ports/connections are available as redundant connections if a fault develops. Reconfiguration of the network using the spanning tree protocol can take from several seconds up to a minute and is therefore not suitable for industrial purposes.

S/STP

Screened Shielded Twisted Pair
With this cable design, the individual twisted pairs of a twisted pair cable are wrapped in a foil screen. Both individually screened pairs are also shielded with a common braided copper shield.

Standard rail

Metal rail standardized in compliance with EN 50 022.
The standard rail is used for fast snap-on installation of suitably designed devices (for example OLM, ELM, OSM)

Structured cabling

Generic cabling system within buildings and building complexes for information technology purposes. The European standard EN 50173 “Application Independent Generic Cabling Systems” contains specifications.
This divides a campus into the following areas

– Primary area (connections between buildings of a campus)
– Secondary area (connections between floors of a building)
– Tertiary area (connections to the DTEs).

EN 50173 recommends cabling systems adapted to these areas that provide the flexibility for the communication requirements of the future independent of specific applications.

Suppressor

Component for reducing induced voltages. Induced voltages occur when circuits with inductances are turned off.

Switch, Switching

A switch is a network component with essentially the same characteristics as a bridge. In contrast to bridges, however, the switch can establish multiple connections between its ports simultaneously. These connections are established dynamically and temporarily depending on the data traffic. Each connection has the full nominal bandwidth.

Terminating resistor

A resistor to terminate Industrial Ethernet triaxial cable; terminating resistors are always necessary at the ends of triaxial cable.

TP cord

A category 5 twisted pair cable for short links; intended for use in a wiring closet or in an office environment with low levels of electromagnetic interference.

Triaxial cable

The SIMATIC NET LAN cable 727-0 is based on the coaxial cable specified in the IEEE 802.3: 10BASE5 standard but with a solid aluminum shield and outer sheath making it more suitable for industrial application.

Twisted pair

Data cable with twisted pairs of wires. Twisting the wire pairs minimizes the electromagnetic interference between the pairs. Twisted pair cables are available in different qualities for different transmission rates.

Abbreviations

ACR

Attenuation **C**rosstalk **R**atio, difference between near end crosstalk and attenuation in dB

APX

Automatic **P**olarity E**x**change

ASGE

Name of an active star coupler for Industrial Ethernet

AS-Interface

Actuator–**S**ensor–Interface, bus system for direct attachment of simple binary sensors and actuators

AUI

Attachment **U**nit **I**nterface, term from the IEEE 802.3 standard

BFOC

Bayonet **F**iber **O**ptic **C**onnector, international designation for fiber–optic connectors®

BN

Bonding **N**etwork

BT

Bit **T**imes

CATx

Category (cable category assigned according to transmission characteristics)

CBN

Common **B**onding **N**etwork

CP

Communications **P**rocessor

CSMA/CD

Carrier **S**ense **M**ultiple **A**ccess with **C**ollision **D**etection, bus access method complying with IEEE 802.3

DIN

Deutsches **I**nstitut für **N**ormung (German Standards Institute)

ECTP3

Name of an Industrial Twisted Pair interface card for the ASGE star coupler

ECFL2/4

Name of a fiber-optic interface card for the ASGE star coupler

ELM

Electrical **L**ink **M**odule

EMC

Electro**m**agnetic **C**ompatibility

EN

Euro**N**orm Standard

ESM

Electrical Switch Module

FDX

Full **D**uple**x**

FO

Fiber **O**ptic

FRNC

Flame retardant non corrosive

HDX

Half **D**uple**x**

HSSM 2

Name of a signaling card for the ASGE star coupler

IEC

International **E**lectrotechnical **C**ommission

IEEE

Institute of **E**lectrical and **E**lectronics **E**ngineers

IK PI

Industrial Communication Catalog (SIMATIC NET product catalog)

ISO

International **S**tandardization **O**rganization

ITP

Industrial **T**wisted **P**air

L+

Positive dc current conductor

L–

Negative dc current conductor

LAN

Local **A**rea **N**etwork

LED

Light **E**mitting **D**iode

LLC

Logical **L**ink **C**ontrol, layer 2b of the OSI reference model

MAC

Media **A**ccess **C**ontrol

MAU

Medium **A**ttachment **U**nit

MDI

Medium **D**ependent **I**nterface

MESH–BN

MESHed **B**onding **N**etwork]

MIKE

Name of a management interface card for the ASGE star coupler

Mini OTDE

Name of an optical transceiver for Industrial Ethernet

Mini UTDE

Name of an electrical transceiver for Industrial Ethernet

N

Neutral conductor

NEXT

Near **E**nd Cross **T**alk

OLM

Optical **L**ink **M**odule

OSI

Open **S**ystem **I**nterconnection, abstract model describing communication between open systems according to ISO 7498

OSM

Optical **S**witch **M**odule

PE

Protective Earth conductor

PELV

Protective **e**xtra–**l**ow **V**oltage

PEN

Combined protective conductor and neutral conductor

PLC

Programmable **L**ogic **C**ontroller

PP

Poly**p**ropylene

PUR

Poly**ur**ethane

PVC

Poly**v**inyl **c**hloride

PVV

Path **V**ariability **V**alue

SELV

Safety **e**xtra–**l**ow **v**oltage

SNMP

Simple **N**etwork **M**anagement **P**rotocol

SQE

Signal **Q**uality **E**rror (”heartbeat”), signal for checking the functionality of a transceiver

S/STP

Screened **S**hielded **T**wisted **P**air

VDE

Verband **D**eutscher **E**lektrotechniker (Association of German Electrical Engineers)

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